FIFTH ANNUAL REPORT

ON THE

NOXIOUS, BENEFICIAL,

AND OTHER

INSECTS,

OF THE

STATE OF MISSOURI,

MADE TO THE STATE BOARD OF AGRICULTURE, PURSUANT TO AN APPROPRIATION FOR THIS PURPOSE FROM THE LEGISLATURE OF THE STATE.

BY CHARLES V. RILEY,

State Entomologist.

JEFFERSON CITY:
REGAN & CARTER, STATE PRINTERS.
1873.

PREFACE.

To the Members of the Missouri State Board of Agriculture:

GENTLEMEN: Herewith I submit, for publication, my Fifth Annual Report on the Noxious, Beneficial and other Insects of the State of Missouri.

The year has been one of abundance, and no one insect has attracted unusual attention or caused very serious alarm. Some, which were unknown and unobserved before, have figured rather prominently, but the great enemies of our staple products have been comparatively harmless, as the sequel will show.

I have given more time than in previous years to lecturing, having responded to the calls of many of our own Agricultural and Horticultural societies, of the Kirksville Normal School, and—outside the State—of Cornell University, N. Y., and of the Kansas State Agricultural College at Manhattan.

It has been a source of true gratification to find my work more and more appreciated, as evidenced in the increasing demand for these Reports, and the more enlightened warfare against noxious insects, which is so noticeable in many sections; and I can not, here, help expressing the wish that our Legislature may be induced to provide for the printing of an extra thousand separate and paper-bound copies of this part of your Report, to meet the increasing demand. Your Secretary is often petitioned for the Entomological Report, which he must needs send with the whole bound Report of the Board, and thus incur unnecessary expense; or else not send at all.

All the figures are made by myself from the natural objects, and mostly engraved by Emil Lampe, and Wm. Mackwitz, of St. Louis.

As in former reports, the older and more familiar generic names are generally employed, and the names in brackets indicate the genera to which the insects are referred in more modern systems.

The name of the author of the species, and not of the genus, is given as authority; and in order to indicate whether or not the insect was originally described under the generic name which it bears, I have adopted, for the first time, the following plan: When the specific name is coupled with the generic name under which it was first published, the describer's name is attached without a comma—thus indicating the authorship of the dual name: e. g. *Phycita nebulo* Walsh. But when a different generic name is employed than that under which the insect was first described, the authorship is inclosed in parenthesis, thus—*Acrobasis nebulo* (Walsh); except where the whole name is already in parenthesis, when a comma will be used for the same purpose: e. g. (*Acrobasis nebulo*, Walsh).

My office is still at Room 29, Insurance Building, south-east corner of Fifth and Olive streets, St. Louis; where all communications should be sent.

My thanks are due to many friends, but more especially to Mr. Otto Lugger and Miss Mary E. Murtfeldt, who have aided me in experiments, and assisted in other ways during my absence from home.

I also thankfully acknowledge the receipt of free passes over the following railroads: St. Louis and Iron Mountain, Missouri Pacific, Atlantic and Pacific, Hannibal and St. Joseph, North Missouri, Chicago and St. Louis, and Illinois Central.

Respectfully yours,

CHARLES V. RILEY,

State Entomologist.

ST. LOUIS, MO., *December* 2, 1872.

ENTOMOLOGY.

ITS RELATIONS TO AGRICULTURE AND ITS ADVANCEMENT.

With brief Instructions for Collecting, Preserving and Studying Insects.

[The following is an amplification of an article published by me in Campbell's New Atlas of Missouri. I incorporate it with this my Fifth Report at the suggestion of members of the Board and others, who think that something of the kind will form a desirable prelude to the Report proper. Judging from the letters of inquiry which reach me day by day, especially with reference to the collecting, preserving and studying of insects, interest in the subject of Entomology is fast increasing in Missouri and the other Western States, and the demand for elementary knowledge increases *pari passu* with the interest manifested. Already in our sister State of Illinois, teachers in the public schools are required to be qualified to instruct in the natural sciences, and natural knowledge is receiving more nearly its due in the schools of our own and of other States, and in the agricultural colleges. It is my desire that Entomology receive its share of attention, and, so soon as leisure permits, I hope to prepare a manual for the special use of these schools, and of which the following prodrome is a mere outline.]

DEFINITION OF ENTOMOLOGY.

It would seem almost superfluous to define the meaning of this word; but from the many letters that come to me addressed "State Etymologist," it is evident that there are those who yet imagine that my office is somehow or other connected with philological science. For the benefit of such, then, Entomology is derived from the Greek, (*εντομον*, insect; *λογος*, discourse,) and constitutes that branch of Natural Science which treats of Insects.

WHAT, THEN, IS AN INSECT?

The term "Insect" is derived from the Latin *insectum*, which signifies "cut into," and expresses one of the chief characteristics of this class of animals; but we can only obtain an intelligent idea of what constitutes an insect by comparison with other animals.

THE ANIMAL KINGDOM.

Animals are variously classified by zoölogists, but the best known and most comprehensive system of classification is that called the Cuvierian, which separates them into four great Branches or Subkingdoms. These are again divided into Classes, Orders, Families, Genera, Species and Varieties, each division being frequently subdivided into minor groups. The four Subkingdoms are:

1—VERTEBRATA or Backbone Animals, comprising the four respective classes of *Mammalia* (mammals), *Aves* (birds), *Reptilia* (reptiles), and *Pisces* (fishes). Normally these all have four limbs, and an internal skeleton to which the muscles are attached.

2—ARTICULATA or Jointed or Segmented Animals, comprising the five classes of *Insecta* (insects), *Arachnida* (spiders, mites, etc.), *Crustacea* (crabs, lobsters, etc.), *Myriapoda* (thousand-legged worms), and *Annelida** (true worms, as leech, earthworm, etc.).

These animals are readily distinguished by their jointed or segmented nature. It is plainly seen in a caterpillar as it crawls along; each joint moves one after the other, with its own peculiar motion; each has its separate set of organs, so that a caterpillar may be said to have a head and 12 distinct bodies attached, for which reason it has 4,000 muscles to move its body, while man has only 529. The jointed character is seen even in the Earthworm and in the Leech, but not in the slug, which is a Molluscous—not an Articulate animal. Articulates are further characterized by having no internal skeleton; they wear their skeleton on the outside, and every one must have noticed the close resemblance which the exterior of the limbs of a grasshopper or of a lobster bears to the bones of our own limbs or to those of other Vertebrates. Sidney Smith wished that, in hot weather, he could put off his flesh and sit in his bones. He ought to have been an Articulate! It is true that some Articulates, and almost all insects in their young and larval days, have this outer skeleton quite soft and delicate; but the same may be said of the internal skeleton of Vertebrates. We may crush and crunch with ease the bones of a newly hatched chick; but he who would undertake to do likewise by those of an old rooster, would, I fancy, have a rather tough job of it!

3—MOLLUSCA or Soft-bodied Animals. These are without distinct joints, and have neither internal nor external skeleton, the surface being soft, flexible and retractile, and often covered with calcareous deposits which assume a variety of different forms.

*Rolleston (*Forms of Animal Life*—a work propounding a more modern system of classification, which, though less simple than the Cuvierian, every zoölogist should study), makes of the *Articulata* two subkingdoms: 1st, ARTHROPODA (ἄρθρον, joint; ποδός, foot), including the tracheate *Insecta*, *Myriapoda* and *Arachnida* and the branchiate *Crustacea*; 2nd, VERMES, including five Classes—thus separating the articulates without legs from those which have legs.

4—RADIATA or Star Animals. These have the body arranged on the plan of an asterisk (*), radiating from a common center. They are often called Zoöphytes, and comprise the very lowest animals—some of which, as the sponges, corals, etc., were for a long time considered plants, and do, indeed, connect the Animal and the Vegetal Kingdoms.

With the exception of a few Molluscous snails and slugs, the animals of the last two Branches live almost entirely in water, and we see that an Insect belongs to the second great Branch, and that it shares the jointed or articulate structure in common with the other animals of that Branch. Wherein, then, does it differ from them? Briefly, in having only 13 joints to the body,* including the head as a joint, and in the adult stage 6 true, jointed legs, and usually (not always) wings. The five classes of Articulates differ from each other in the number of legs they possess in the adult form, as follows: *Insecta*, 6 legs; *Arachnida*, 8; *Crustacea*, 10–14; *Myriapoda*, more than 14; *Annelida*, none.

I say TRUE legs and in the ADULT form, because there are some mites (Class *Arachnida*) which, when young, have six legs only, while many insects have additional legs in their preparatory or adolescent stages, which are not jointed, but membranous, and are lost in the perfect stage: these are called false, sham, or prolegs.

Insects are further characterized by having the body divided into three distinct parts: the *head*, which bears the sense organs; the *thorax*, which bears the organs of locomotion; and the *abdomen*, which bears the reproductive organs. They also undergo a series of molts, and exist in four distinct stages: 1st, the *egg* stage; 2nd, the *larva* (meaning masked—the future and ultimate form being usually masked or hidden, so far as external appearance goes) or active stage; 3rd, the *pupa* (sometimes called chrysalis or nymph) or usually quiescent stage; 4th, the *imago* or perfect stage, in which alone the wings appear. To be brief, then, I would give the following definition of an Insect: *A 13-jointed, 6-legged animal, with an external skeleton; undergoing transformations or metamorphoses, and breathing through spiracles (breathing holes) which lead to tracheæ (air tubes): the body in the adult divided into three distinct parts (head, thorax and abdomen); with or without wings.*†

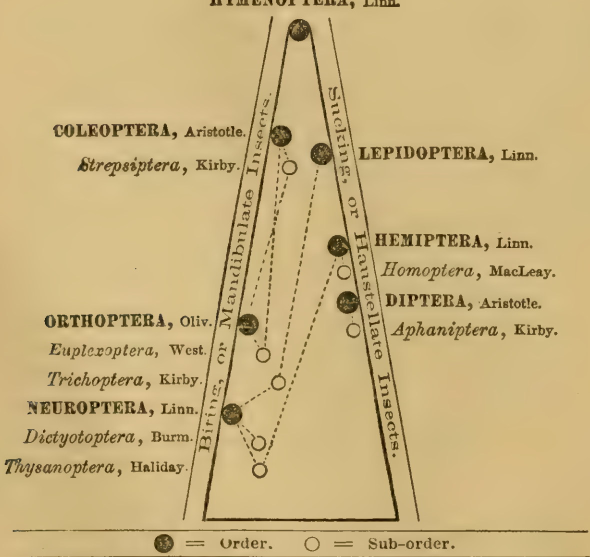
*An additional subjoint is often apparent, and sometimes very fully developed, as, for instance, in the larva of *Passalus cornutus* (4th Rep., Fig. 62, *a*).

†I fancy the exclamation from some curious reader—"Well, why, if the possession of 13 joints and 6 articulate legs be so true a test of an insect, do some authors include the spiders and thousand-legged worms in the same Class and call them insects? Does not Packard in his 'Guide to the Study of Insects' give us in his first figure a 21-jointed larva as typical of the Class, and does he not give us three Orders in the Class, elevating the *Arachnida* and *Myriapoda* to the same rank as *Insecta*; and has not this arrangement the sanction of such eminent men as Agassiz and Dana?" It is true, there is some dispute as to how many *typical* joints the head of insects is composed of, Packard himself arriving at different conclusions in the first and third editions of his work; while the figure referred to might convey the impression above expressed. But all the discussion on the first head is more or less hypothetical, and the larva represented by the figure referred to is only *apparently* 21-jointed, being that of

CLASSIFICATION.

This subject may be disposed of in few words, though we can not speak intelligently of insects, without some idea—however general—of their relations. In treating a subject about which so much has been written, the study should be what *not* to say, rather than *what* to say. All insects, as just defined, are referable to one or the other of seven well-defined Orders, founded on the structure of the mouth in the imago, the number and nature of the wings and the transformations. Some of these Orders are, however, connected by aberrant and osculant families, or groups, which have, by certain authors, been ranked as independent Orders; but which it will be more convenient—if not more natural—to consider Suborders. In my lectures I have found it very convenient to make use of the following pyramid, (Fig. 1), which gives at a glance the distinguishing characters and the relative rank of these seven Orders and of the osculant groups:

[Fig. 1.]



Pyramid showing the nature of the mouth, and relative rank of the Orders, and the affinities of the Sub-orders of Insects.

Scenopinus, and, as explained by Packard himself, (*Guide*, p. 401), remarkable for the double-segmented appearance of all the abdominal joints, except the last one, so that the body appears to have 21 instead of 13 joints. As to the different classifications, authors have differed in the past and will differ in the future, as to what constitutes a natural system; and to attempt to harmonize or even consider the various plans would be to discuss words and not things. Remembering that classifications are but means to an end—appliances to facilitate our thought and study; and that, to use Spencer's words, "we can not by any logical dichotomies, accurately express relations which in nature graduate into each other insensibly," the difference of opinion becomes intelligible; and for my part I adopt that system which appears most natural, and which best promotes the object in view. It is essentially that of Westwood, given in his "Introduction," which has justly been called the entomologist's bible. Those who include the *Arachnida* and *Myriapoda* in the same Class with Insects, must particularize the latter

[Fig. 2.]

BEMBEX FASCIATA.

1—HYMENOPTERA (υμην, a membrane; πτερα, wings), Clear or Membrane-winged Flies. Bees, Wasps, Ants, Saw-flies, etc. Characterized by having four membranous wings with comparatively few veins (Fig. 2), the hind pair smallest. The transformations are complete: i. e., the larva bears no resemblance to the perfect insect.

Some of the insects of this Order are highly specialized, and their mouth parts are fitted both for biting and sucking, and in this respect they connect the mandibulate and haustellate insects. The common Honey-bee has this complex structure of the mouth, and if the editors of our agricultural papers would bear the fact in mind, we should have less of the never-ending discussion as to whether bees are capable of injuring fruit at first hand. The lower lip (*labium*) is modified into a long tongue, sheathed by the lower jaws (*maxillæ*), and they can sip, or, more properly speaking, lap up nectar; while the upper jaws (*mandibulæ*), though not generally used for purposes of manducation, are fitted for biting and cutting. The Hymenoptera are terrestrial, there existing only a very few degraded, swimming forms.

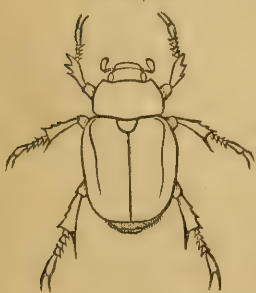
This Order is very naturally divided into two sections — the *Aculeata* and *Terebrantia*. The aculeate Hymenoptera, or Stingers, comprise all the families in which the abdomen in the female is armed with a sting connected with a poison reservoir, and may be considered the typical form of the Order, including all the social and fossorial species. The insects of this section must be considered essentially beneficial to man, notwithstanding the occasional sting of a bee or wasp, the boring of a carpenter-bee, or the importunities of the omnipresent ant. Not only do they furnish us with honey and wax, but they play so important a part in the destruction of insects injurious to vegetation that they may be looked upon as God-appointed guards over the vegetal kingdom — carrying the pollen from plant to plant, and insuring the fertilization of diœcious species, and the cross-fertilization of others; and being ever ready to clear them of herbivorous

as hexapods or hexapod insects, and relegate the long-accepted natural Orders to the rank of Suborders. This departure from stricter definitions is defended principally on embryological data, which though of great value as pointing to the derivation of insects—their homologies and relations to the past—do not always subserve the best interests of classification. It would be absurd, for instance, to class man with the reptiles or fishes, because, embryologically, up to a certain stage he can not be distinguished from members of those Classes; and we should, for the most part, confine ourselves to mature forms and external characters in classification. Finally, insects proper, (as defined in the italics,) spiders and millipeds have so many characters that are not common to all, that it is very inconvenient to consider them as belonging to one Class. This inconvenience—not to say incorrectness—is apparent in the writings of many of those who adopt the plan; for their general descriptions of the organs and parts of an INSECT, and especially of the three great divisions into head, thorax and abdomen, apply solely to hexapod articulates, and can not apply to the *Arachnida*, which have but two, or to the *Myriapoda*, which have no great divisions of the body. It is no wonder, therefore, that in separating the *Arachnida* from *Insecta*, Lamarck has been so generally followed. Perhaps, as has been suggested by Dr. Packard in the third edition of the excellent work referred to, these three divisions might best be considered Subclasses.

worms which gnaw and destroy. The whole section is well characterized by the uniformly maggot-like, legless nature of the larva. The transformations are complete, but the chitinous larval covering is often so very thin and delicate that the budding of the members, or gradual growth of the pupa underneath, is quite plainly visible, and the skin often peels off in delicate flakes, so that the transition from larva to pupa is not so marked and sudden as in those insects which have thicker skins.

The terebrantine Hymenoptera, or Piercers, are again divisible into two subsections: 1st, the ENTOMOPHAGA, which are likewise, with the exception of a few gall-markers, beneficial to man; 2d, the PHYTOPHAGA, comprising the Horn-tails (*Uroceridæ*), and the Saw-flies (*Tenthredinidæ*), all of which are vegetable feeders in the larva state, those of the first family boring into the trees, and those of the second either feeding externally on leaves, or inclosed in galls. They are at once distinguished from the other Hymenoptera by the larvæ having true legs, which, however, in the case of the Horn-tails, are very small and exarticulate. The larvæ of many Saw-flies have, besides, prolegs, which are, however, always distinguishable from those of Lepidopterous larvæ by being more numerous and by having no hooks.

[Fig. 3.]



COTALPA LANIGERA.

2—COLEOPTERA (*Κολεος*, a sheath; *πτερα*, wings), Beetles or Shield-winged Insects. Characterized by having four wings, the front pair (called *elytra*) horny or leathery, and usually united down the back with a straight suture when at rest, the hind ones membranous and folded up under the elytra when at rest (Fig. 3). Transformations complete.

This is an Order of great importance, and in the vast number and diversity of the species comprised in it outranks any of the others. The ease with which the insects of this Order are obtained and preserved makes it one of the most attractive to the amateur, and beetles are, perhaps, of all insects, the best known and understood in the popular mind. For the same reason they have, in the perfect state, received most attention from entomologists; but their transformations and preparatory forms yet offer a wide and inviting field for the student. The simplest and best-known classification of the beetles is the tarsal system, founded on the number of joints to the tarsi, by which we get four great sections: 1, PENTAMERA, in which all the tarsi are 5 jointed; 2, HETEROMERA, with the four anterior 5-jointed and the two posterior 4-jointed; 3, PSEUDO-TETRAMERA, with apparently only 4 joints to all the tarsi, though, in reality, there is a fifth penultimate joint, diminutive and concealed; 4, PSEUDO-TRIMERA, with apparently only 3 joints to all the tarsi. This system, like most others, is not perfect, as

there are numerous species not possessing five joints to the tarsi belonging to the first section; and for practical purposes beetles may be very well arranged according to habit. We thus get, 1st, the ADEPHAGA, or carnivorous species, including all those which prey on other living insects, and to which, following Mr. Walsh, I have, for obvious reasons, applied the suggestive term "Cannibal"; 2d, the NECROPHAGA, comprising those which feed on carrion, dung, fungi and decaying vegetation; 3d, the PHYTOPHAGA, embracing all those feeding on living vegetation. This arrangement is by no means perfect, for there are beetles which are carnivorous in the larva and herbivorous in the imago state; while some of the *Necrophaga* are actually parasitic. Yet, it is not more artificial than others which have been proposed. The carnivorous species, broadly speaking, are *Pentamerous*, the only striking exception being the *Coccinellidæ* (Lady-birds), which are *Pseudo-trimerous*. The carrion-feeders are also *Pentamerous;* but vegetable-feeders are found in all the tarsal divisions, though the *Pseudo-tetramera* are the more essentially herbivorous, and consequently the most injurious.

[Fig. 4.]

DEIOPEA BELLA.

3—LEPIDOPTERA (λεπις, a scale; πτερα, wings), Butterflies and Moths, or Scaly-winged Insects. Characterized by having four branching-veined, membranous wings, each more or less densely covered on both sides with minute imbricated scales which are attached by a stalk, but which easily rub off, and appear to the unaided eye like minute particles of glistening dust or powder. Transformations complete. (Fig. 4.)

Next to the *Coleoptera*, the *Lepidoptera* are, perhaps, most familiar to the popular mind. Every one admires the beauty of these frail creatures, dressed in every conceivable pattern, and adorned with every conceivable color, so as to rival the delicate hues of the rainbow, and eclipse the most fantastic and elaborate designs of man. When magnified, the scales, to which this beauty of pattern and coloring is entirely due, present all manner of shapes, according to the particular species or the particular part of the individual from which they are taken. According to Lewenhœck, there are 400,000 of these scales on the wing of the common silk-worm.

The transformations of these insects are complete, and the changes are usually so sudden and striking, as to have excited the wonder and admiration of observers from earliest times.

The more common form of the larva is exampled in the ordinary caterpillar—a cylindrical worm with a head, twelve joints and a subjoint; six thoracic or true legs, four abdominal and two anal prolegs. But there is a great variety of these larvæ, some having no legs whatever, some having only the jointed legs, and others having either

four, six, eight or ten, but never more than ten, prolegs. With few exceptions they are all vegetable feeders, and, with still fewer exceptions, terrestrial. The perfect insects make free use of their ample wings, but walk little; and their legs are weak, and not modified in the various ways so noticeable in other orders, while the front pair in some butterflies are impotent.

As an Order this must be considered the most injurious of the seven.

A convenient system of classification for the *Lepidoptera* is based on the structure of the antennæ. By it we get two great sections: 1st, Butterflies (RHOPALOCERA); 2nd, Moths (HETEROCERA), which latter may again be divided into Crepuscular and Nocturnal Moths. Butterflies are at once distinguished from moths by their antennæ being straight, stiff and *knobbed*, and by being day-flyers or diurnal; while moths have the antennæ tapering to a point, and are, for the most part, night-flyers or nocturnal. The crepuscular moths, composed mostly of the Sphinges or hawk-moths, hover over flowers at eve, and not only connect the two sections in habit, but in having antennæ which first thicken toward the end, and then suddenly terminate in a point or hook.

[Fig. 5.]

EUSCHISTES PUNCTIPES.

[Fig. 6.]

CERESA BUBALUS.

4—HEMIPTERA (ἥμισυ, half; πτερα, wings), Bugs. The insects of this Order are naturally separated into two great sections: 1st, Half-winged Bugs, or *Heteroptera* (ἑτεροῖς, different; πτερα, wings) having the basal half of the front wings (called *hemelytra*) coriaceous or leathery, while the apical part is membranous. The wings cross flatly over the back when at rest. (Fig. 5.) 2d, Whole-winged Bugs or *Homoptera* (ὁμός, equal; πτερα, wings), having all four wings of a uniform membranous nature and folding straight down the back when at rest. (Fig. 6.) The latter, if separated, may be looked upon as a Suborder.

Transformations incomplete: *i. e.*, the larva has more or less the image of the perfect insect, and differs little from it except in lacking wings.

The genuine or Half-winged Bugs are usually flattened in form when mature, though more rounded in the adolescent stages. They may be divided into Land Bugs (AUROCORISA) and Water Bugs (HYDROCORISA). The species of the first division very generally possess the power of emitting, when disturbed or alarmed, a nauseous, bed-buggy odor, which comes from a fluid secreted from two pores, situated on the under-side of the metathorax. Such well-known insects as the Bed-bug and Chinch-bug belong here. The habits of the species are varied, and while some are beneficial, others are quite injurious to man.

The Whole-winged Bugs, on the contrary, are all plant-feeders, and with the exception of a few, such as the Cochineal and Lac insects, are injurious. The secretion of a white or bluish, waxy or farinose substance, from the surface of the body, is as characteristic of this section as the nauseous odor is of the first. It forms three natural divisions, arranged according to the number of joints to the tarsi—namely, TRIMERA, with three joints; DIMERA, with two joints, and MONOMERA, with one joint to the tarsi.

[Fig. 7.]

ASILUS MISSOURIENSIS.

5—DIPTERA (δις, twice; πτερα, wings) or Two-winged Flies. The only Order having but two wings, the hind pair replaced by a pair of small, slender filaments clubbed at tip, and called halteres, poisers, or balancers. (Fig. 7.)

No Order surpasses this in the number of species or in the immense swarms of individuals belonging to the same species which are frequently met with. The wings, which are variously veined, though appearing naked to the unaided eye, are often thickly covered with very minute hairs or hooks. As an Order, the *Diptera* are decidedly injurious to man, whether we consider the annoyances to ourselves or our animals, of the Mosquito, Buffalo-gnat, Gad-fly, Breeze-fly, Zimb or Stomoxys, or the injury to our crops of the Hessian-fly, Wheat-midge, Cabbage-maggot, Onion-maggot, etc., etc. There are, in fact, but two families, *Syrphidæ* and *Tachinidæ*, which can be looked upon as beneficial to the cultivator, though many act the part of scavengers. No insects, not even the Lepidoptera, furnish such a variety of curious larval characters, and none, perhaps, offer a wider or more interesting field of investigation to the biologist. It is difficult to give any very satisfactory arrangement of these Two-winged flies, though they easily fall into two rather artificial sections. These are: 1st, NEMOCERA, or those with long antennæ, having more than six joints, and palpi, having four or five joints. The pupa is naked, as in the *Lepidoptera*, with the limbs exposed. This kind of pupa is called *obtected.* 2d, BRACHOCERA, or those with short antennæ, not having more than three distinct joints, and palpi with one or two joints. The pupa is mostly *coarctate*, *i. e.*, is formed within, and more or less completely connected with, the hardened and shrunken skin of the larva.

The most anomalous of the Diptera are the Forest-flies and Sheep-ticks (*Hippoboscidæ*). They have a horny and flattened body, and resemble lice in their parasitic habits, living beneath the hairs of bats and birds. Their mode of development has always attracted the attention of entomologists. The larvæ are hatched in the abdomen of the female, which is capable of distention. There it remains, and, after assuming the pupa state, is deposited in the form of a short, white,

egg-like object, without trace of articulation, and nearly as large as the abdomen of the parent fly. Closely allied to these are the Bat-ticks (*Nycteribidæ*), which possess neither wings nor balancers, and remind one strongly of spiders.

In this Order we may also place certain wingless lice (such as *Braula cœca*, Nitzsch — figured by Packard), which infests the Honey-bee in Europe, but which has not yet been detected in this country.

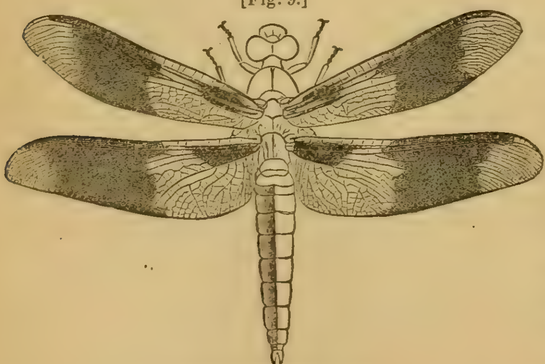
[Fig. 8.]

ŒDIPODA DIFFERENTIALE.

6 — ORTHOPTERA (*ορθος*, straight; *πτερα*, wings) or Straight-winged Insects. Characterized by having the front wings (called *tegmina*,) straight and usually narrow, pergameneous or parchment-like, thickly veined and overlapping at tips when closed: the hind wings large and folding longitudinally like a fan. (Fig. 8.) Transformations incomplete.

The insects of this Order have a lengthened body and very robust jaws, with a correspondingly large head. The legs are strong, and fashioned either for grasping, running, climbing, jumping or burrowing. As in the other Orders where the transformations are incomplete, the young differ little from the parent, except in the want of wings; and in many instances even this difference does not exist, as there are numerous species which never acquire wings. There are no aquatic *Orthoptera*. Some are omnivorous, others carnivorous, but most of them herbivorous. They form four distinct sections: 1st. CURSORIA, cockroaches; 2d. RAPTATORIA, Mantes; 3d. AMBULATORIA, Walking-sticks; 4th. SALTATORIA, Crickets, Grasshoppers and Locusts.

[Fig. 9.]



LIBELLULA TRIMACULATA.

7—NEUROPTERA (*νευρον*, nerve; *πτερα*, wings) or Nerve-winged insects. Characterized by having the wings reticulate with numerous veins so as to look like net-work. (Fig. 9.) The Order forms two natural divisions, the first including all those which undergo a complete, and the second, called *Pseudo-neuroptera*,(=*Dictyotoptera*, Burmeister), those which undergo an incomplete metamorphosis. The latter, when separated, may be considered a suborder. The insects of this Order are, as a whole, more lowly organized, and more generally aquatic than either of the others. A natural arrange-

ment of them is difficult, on account of their degradational character. They present forms which are synthenic and closely approach the other Orders, and the evolutionist naturally looks upon them as furnishing an idea of what the archetypal forms of our present insects may have been. They are, as a rule, large and sluggish, with the body parts soft and little specialized, and the muscles weak. Their remains are found in the Devonian and Carboniferous deposits.

They are mostly carnivorous, and with the exception of the White ants and certain Book-lice, they none of them affect man injuriously, while some are quite beneficial.

The osculant and aberrant groups, already spoken of, and the proper position of which has so perplexed systematists, are:

1—STREPSIPTERA (στρεψις, a turning or twisting; πτερα, wings) or Bee parasite, comprising the single family *Stylopidæ*, now classed with the *Coleoptera*. They are minute insects, with the front wings transformed into short, twisted appendages and the hind wings large and folded longitudinally like a fan. They are most remarkable animals, undergoing what is termed hypermetamorphoses* and having a curious life-history. The young are very minute, active, six-legged objects, with two fine hairs or setæ at the tip of the abdomen. They crawl on to the legs of different species of bees and wasps, are carried into the nests of the latter, and there live on the bee larvæ, changing appearance at each molt and assuming a more degradational form. On account of their very small size, and the few which generally attack a single bee-larva, they do not kill their host, or prevent him from completing his transformations; and while the infested bee is flying about, the parasitic and degraded *Stylops* larva stations itself under one of the abdominal joints on the back, whence the active winged male issues, and where the female—who never acquires wings—is destined to remain, receive the male, and give birth to young within her own body.

2—APHANIPTERA, (αφανης, inconspicuous; πτερα, wings) or Fleas, comprising the single family *Pulicidæ*, now placed with the *Diptera*. Everybody is supposed to be familiar with the appearance of the flea—its bloodthirsty propensities and amazing muscular power; and while every one may not have the leisure and means to experience the exhilarating influence of the chase after larger animals, there is no one—be he never so humble—who may not indulge in the hunt after this smaller game! In place of wings the flea has four small scaly plates. The minute eggs—about a dozen to each female—are laid in obscure places, such as the cracks of a floor, the

*i. e., before reaching the third or *pupa* stage, the larva assumes other distinct forms, so that instead of existing only in the normal four stages, characteristic of most insects, those which go through hypermetamorphoses, exist in five or six stages, according to the number of distinct larval forms.

hair of rugs, etc., and the larva is worm-like and feeds on whatever animal matter—as grease and blood—it can find.

3—EUPLEXOPTERA, (ευ, well; πλέχω, folded) or Earwigs, consisting of the single family *Forficulidæ*, which may be placed with the *Orthoptera*. They are rare insects with us, but very common in Europe, where there prevails a superstition that they get into the ear and cause all sorts of trouble. The front wings are small and leathery; the hind ones have the form of a quadrant and look like a fan when opened; and the characteristic feature is a pair of forceps-like appendages at the end of the body, best developed in the males. They are nocturnal in habit, hiding during the day in any available recesses. The female lays her eggs in the ground, and, singularly enough, broods over them and over her young—the latter crowding under her like chicks under a hen.

4—TRICHOPTERA, (τριχος, of hair; πτερα, wings) or Caddice-flies, containing the single family *Phryganeidæ*, and placed with the *Neuroptera*, though bearing great affinities with the *Lepidoptera*. Every good disciple of Walton and lover of the "gentle art" knows the value of the Caddice-fly or Water-moth, as bait. These flies very much resemble certain small moths, the scales on the wings of the latter being replaced in the former with simple hairs. The larvæ live in the water and inhabit silken cases, which are usually cylindrical and covered with various substances, according to the species, or the material most conveniently obtained by the individual.

5—THYSANOPTERA (θυσανος, a fringe; πτερα, wings) or Thrips of entomologists, containing the single family *Thripidæ*, which may be placed with the *Pseudo-neuroptera*, though bearing strong relations to the *Hemiptera*. They are small insects, feeding on plants, or other plant-feeding species of their own Class, and are characterized by having narrow wings crossed on the back when at rest and beautifully fringed.

Prof. Westwood of Oxford, England, has lately proposed an additional Order (*Achreioptera*) to contain a single species (*Platypsyllus castorinus*) parasitic on the Canadian beaver, but Mon. Ritsema, who also described the same insect about the same time, hesitated to found even a new Family for it; while our own Coleopterist, Dr. J. L. LeConte, gives good reasons for placing it with the Coleoptera.

As already stated, if separated from the other Orders, these abnormal tribes should, at the most, be considered as Suborders; and in reality they differ no more from the Orders to which they are here referred than, for instance, the Bark-lice (*Coccidæ*) do from the more typical *Homoptera* from which no one thinks of separating them.

IMPORTANCE OF ENTOMOLOGY AS A STUDY.

Time was when the entomologist was looked upon as a mere trifling enthusiast. The derisive term "bug-hunter" was applied to him, as though his sole occupation in life was to run after and catch "bugs." So long as he contented himself with such trivial doings, the epithet was, perhaps, not undeserved; but that day has long since passed away! A whole galaxy of illustrious names—Schwammerdam, Ray, Rösel, Réaumur, De Geer, Latreille, Lamarck, Lyonnet, Linnæus, Fabricius, Kirby, Spence, Harris, Say, and others, of days gone by, and hundreds of others of the present day—stand forth to redeem the science of entomology from such obloquy; and I hazard nothing in the statement that not even her sister science, botany, may boast of a literature more extensive or more worthy, whether judged by its intrinsic merit as pabulum for the philosopher, as a storehouse of facts for the practical man, or as a conscientious and accurate presentation of the pure and unalloyed truths of nature. I am aware that, among those who have never opened the pages of her vast treasure-book, there is yet a prevailing belief that insects are little, contemptible things, unworthy any special attention on our part; but if it does not detract from our idea of the majesty of a Creator to have produced myriads upon myriads of these tiny beings, so perfect in their many parts that Solomon in all his glory was not arrayed like the very meanest of them, it should not, surely, derogate from man's dignity to study them in all their infinitesimal perfection. Nothing is great or small but by comparison. The earth is a mere mustard seed compared to the sun, and the sun, viewed in comparison with the host of starry suns scattered through infinite space, sinks into complete insignificance. Now, what should we say of a school-boy who objected to study geography because the earth was too small a body to be worthy his attention?

In common with all the other sciences, Entomology, viewed solely as an educator, enriches the human mind by adding to its store of knowledge; and has few, if any, equals as a means of developing the observing faculties of the young. The life-habits of insects—their wonderful metamorphoses, their instructive industries—furnish ample food for reflection, and for our natural love of the curious and marvelous; and it is surprising that the fact has not been more fully recognized in our educational systems. Botany has long since had her place in our schools, and her importance as a means of mental training is not ignored. Yet lessons in animal life—the histories of living, sentient, active creatures—can certainly be made as instructive and entertaining as lessons in vegetative plant-life, and should receive as much or more attention.

ECONOMIC IMPORTANCE OF ENTOMOLOGY.

Man receives some direct benefits from insects, which fact may be well brought home by taking for example the case of a young lady dressing for an evening party:—Her card of invitation is written with ink, the principal ingredient in which—if it is good ink—is the gallic acid made from the so-called "gall-nut" produced by a little gall-fly (*Cynips gallæ-tinctoriæ* Oliv.) on the leaves of a species of Oak (*Quercus infectoria*) very common throughout the Levant. The sealing-wax which fastens the envelope inclosing the invitation is made mainly of shellac, the product of a species of bark-louse (*Coccus lacca* Kerr) found on various trees, such as the Jujube and Indian fig, in India. Her toilet table is, of course, illumined with wax tapers, and for these she is indebted to the common Honey-bee, (*Apis mellifica*), a naturalized American citizen. If she is a *fashionable* young lady, the very rouge on her cheeks is prepared from lac-lake, made either from the bark-louse above mentioned or from the Cochineal. The silk that enters into various portions of her dress comes from the Silk-worm, artificially propagated in many parts of Europe and Asia, and now beginning to attract renewed attention in some parts of our own country. Her dress is probably dyed with cochineal, an extract from the dead bodies of another species of bark-louse (*Coccus cacti* Hern.) artificially propagated on cacti in Mexico. Finally, if the young lady contracts some inflammatory cold, the chances are that her physician will apply to her person a blister prepared from cantharides, the dried and powdered bodies of a Spanish blister-beetle, of which we annually import large quantities at great expense, because our pharmaceutists are ignorant of the fact that we have some half-dozen indigenous species belonging to the same family, the vesicatory properties of some of which are every bit as good, and which are so common during certain years that they are among the most serious enemies of that valuable esculent, the Potato. Indirectly, insects are also of essential service to us; some acting as guards over the vegetable world by destroying the herbivorous species of their own Class, some as scavengers in clearing away decaying animal and vegetal matter; while others perform a most important part in the pollenation of plants.

But the direct or indirect benefits we derive from insects are trivial compared with the damage they do us, as destroyers of our crops. It is, therefore, in

THE RELATION OF INSECTS TO AGRICULTURE,

That they more particularly interest us. In his essay on "What I Know of Farming," the lamented Horace Greeley says:—

"If I were to estimate the average loss per annum to the farmers of this country from insects at $100,000,000, I should doubtless be far

below the mark. The loss of fruit alone by the devastations of insects, within a radius of fifty miles of this city, must amount in value to millions. In my neighborhood the peach once flourished, but flourishes no more, and cherries have been all but annihilated. Apples were till lately our most profitable and perhaps our most important product; but the worms have taken half our average crop, and sadly damage what they do not utterly destroy. Plums we have ceased to grow or expect; our pears are generally stung and often blighted; even the currant has at last its fruit-destroying worm. We must fight our paltry adversaries more efficiently, or allow them to drive us wholly from the field."

The above estimate, great as it seems, is, I believe, far below the mark; and, indeed, it is only when we begin to make careful computation of the average annual loss to this country by insect depredations, and express the sum in round numbers, that we can form any intelligent conception of its magnitude. The State of Missouri, alone, loses annually from fifteen to twenty million dollars, at the very least, and the loss to the Southern cotton-growing States, the present year, within a single fortnight, by a single insect, (the Cotton-worm, *Anomis xylina*), was lately estimated at twenty millions. There is not the least doubt but that the damage inflicted by insects on the farmers of the United States exceeds tenfold the united damages of all other animals put together. It is rarely, if ever, that entire crops are destroyed by birds, rats or squirrels; yet we all know that a single minute insect—the Chinch-bug—often so injures a crop of wheat that it is not worth the cutting.

PROGRESS OF ECONOMIC ENTOMOLOGY.

It is upward of a century since the Swedish authorities became greatly alarmed at the fearful destruction of timber in their dock-yards, caused by a minute boring beetle (*Lymexilon navale*). They did the very best thing they could have done, under the circumstances—they applied to their celebrated entomologist, Linnæus. After a tedious investigation, Linnæus found that the perfect beetle which laid the eggs from which proceeded all the mischief, appeared in the month of May, and in no other month. So he said to the authorities—"Gentlemen, all you have to do is to immerse your timber under water during the month of May, and you will be no more troubled with *Lymexilon navale*." The Government did so—for the remedy was simple and inexpensive; and the result was as Linnæus had predicted. From that time forth, the importance of a knowledge of insect economy as a means of preventing the depredations of the pests which affect our products, began to be realized; and the growth of Economic Entomology began. In Prussia and many parts of Germany—where the appreciation of true science has done so much to elevate the nation—the rudiments of Entomology are taught in the common schools; and in the great agricultural colleges there are often special Professors of this department, distinct from the Professors of the other departments of natural history. Their best text-books devote

a great deal of space to Entomology, as witness that of Troschel and Ruthe, and especially that of Leunis, of which there are several editions for the use of the different classes. They possess, also, many excellent works entirely devoted to the science applied.

Ratzeburg, who held the position of entomologist to the King of Sweden up to the time of his recent death, was appointed by the government; and his world-renowned works on "Forest Trees, their Diseases, and Insect Enemies," have done much to build up the industries of that country, and to preserve the natural forests.

In France, again, before the late fearful war so prostrated her, and when there was an enlightened despotism centralized at Paris, a wise surveillance of her agricultural interests was maintained—especially with reference to insect depredations. They had a National Agrico-entomological Society which held annual exhibitions at Paris, and they also had a monthly journal especially devoted to what the editors were pleased to term agricultural insectology; and only a few months before the war broke out, the Government, to stimulate research, offered a prize of 20,000 francs for a remedy for the Grape-root disease which has lately caused such consternation in the southern part of that country, and which likewise greatly interests the people of the United States, as the readers of these Reports are aware. I am glad to see that under the present Government the offer has been renewed, and that the interest in Economic Entomology is not abating; for there is being held at Paris—as I write—under the auspices of the Central Society of Agriculture, an exhibition of useful insects and their products, and of noxious insects and their injuries. Questions in entomology as well as in general zoölogy are also made part of every examination in their colleges.

In England, where agriculture is not so much relied on, and where insects are not so troublesome to the agriculturist, the authorities have been more indifferent, though the economic writings of J. O. Westwood, and the excellent work on "Farm Insects," by John Curtis, have done much good; and from the fact that an entomologist has lately been officially connected with the South Kensington Museum of London, we may infer that increased attention is there being given to the subject. That the pure science is appreciated there, we may infer from the fact that the first-named author—so celebrated as an entomologist—holds the Hope professorship of Entomology and Zoölogy at Oxford University.

But it is to our own country that we must look for the greatest progress. As is the exigency, so will be the effort. America has been justly termed the land of insects. The vast extent of our country and the great number of species contained within its limits; the fashion which our farmers have of scattering their energies over large tracts, instead of concentrating them on smaller and better-managed farms; the great number of noxious insects imported from foreign lands; the

rich feast which our varied and extensive flora affords—all tend to make it a sort of insect pandemonium. While in Europe the whole people become alarmed if a fifth of a given crop is destroyed by insects, the cultivator here often thinks himself fortunate if he loses not more than half. And yet the sums so far paid out by our State and National Governments appear paltry indeed in view of the loss sustained. It is as if a gigantic army of foreign soldiers was actually among us—burning, ravaging and destroying—and the authorities, after taking the matter into their grave consideration, were to vote $1,000 a year to General Sherman, and smaller sums to two or three other officers, and for the maintenance of the Military School at West Point, and the forts, arsenals, dock-yards and navy-yards of the country. For a long time, New York was the only State that employed a salaried entomologist, and during the last sixteen years the able and celebrated incumbent has issued numerous Reports. The salary he received sixteen years ago was $1,000 per annum, which, though it went three times as far at that time as it does at present, was yet scarcely sufficient to defray his annual expenses in books. Notwithstanding the great change sixteen years have produced in valuations, this salary has not been increased; and should we wonder, as old age fastens its enervating hand upon him, to find him losing interest and becoming indifferent? Yet notwithstanding the office in New York State had lately become nearly obsolete and useless on account of the insufficient salary, and was finally abolished last winter, the effect of Dr. Fitch's earlier work is still felt, and Senator A. B. Dickinson, a few years ago, gave it as his deliberate opinion that the New York Entomological Reports had saved annually to the State over $50,000. Massachusetts once voted a sum of money to Harris for a Report on the Injurious Insects of Massachusetts, (and, to his honor be it said, Mr. Thomas Allen, the enterprising and intelligent President of our Iron Mountain Railroad, had much to do in getting the vote through), and Dr. Harris expressly states that he was obliged to procure a great number of books at an expense far exceeding the compensation allowed him. Yet this Report has become a standard work to-day, has run through four editions, and is not only an honor and credit to the State, but, besides the incalculable good which it must have done, has doubtless brought in a revenue far exceeding the original cost to the State. There is also at present, and has been for some time, an entomologist, Mr. Townsend Glover, attached to the Department of Agriculture at Washington; but, as he himself has often informed me, besides his regular duties, he is not only called upon to receive, arrange and take care of specimens of birds, specimens of fruits, specimens of grain, specimens of flax, specimens of hemp, specimens of cotton, and specimens of silk, but must also act as general curator to the Museum. This is a good deal like hiring a single cradler to harvest 10,000 acres of wheat, and then expecting

him, in addition, to cut and fetch in wood, peel and wash the potatoes, and be always on hand ready to wait on the good woman of the house. Can we wonder, under such circumstances, that the Entomological Reports from the Department do not contain a world of original and practical information? When Mr. Glover should have been studying the Insects, he was called off to attend the Birds. If he intended to discover some facts about the Army-worm, he was hurried away to unpack a bushel of apples. And instead of learning how to master the Curculio, his time was occupied in classifying and arranging specimens of flax, hemp, cotton, etc.! As if Entomology required neither time, study nor attention! Those who have the pleasure of Mr. Glover's acquaintance know full well that there are few harder working men than he; but his position is by no means enviable. Entomology is enough for one man to shoulder, without having all the other ologies piled on his back.

In the East, Dr. A. S. Packard holds the office of State Entomologist in Massachusetts; and Dr. I. P. Trimble has somehow or other been supposed to hold a similar office in New Jersey, though with no State authority. Prof. S. I. Smith, of New Haven, has lately been appointed Entomologist to the State Board of Agriculture of Connecticut, and the celebrated Neuropterist, Dr. H. A. Hagen, is Professor of Entomology at Harvard. In the middle States, Michigan and Iowa have entomologists attached to their agricultural colleges; but in each instance the position is a sort of adjunct to something else. Illinois, always wise, and leading in the higher walks of Agriculture, was the first to establish the office of State Entomologist in the so-called West. In the winter of 1866–7, the Legislature enacted a law creating the office, and on the 11th of June, 1867, the Governor very judiciously appointed to it Mr. Benj. D. Walsh, of Rock Island, a gentleman who had been the principal editor of the *Practical Entomologist*, a journal published in 1865 and 1866 in Philadelphia, and solely devoted, as its name implies, to practical entomology.

Following the example of her sister State, Missouri—through the efforts of a few of her more progressive and intelligent citizens, and especially of Norman J. Colman, editor of the *Rural World*—created the office of State Entomologist, and endowed it by a special appropriation to the State Board of Agriculture, under whose direction the incumbent acts. In April, 1868, the writer was called to fill the position. In the fall of the same year Mr. Walsh and myself commenced the publication of the *American Entomologist* (a monthly journal devoted to economic entomology) at St. Louis, in order to supply needed information pending the publication of our annual reports. But a sad and cruel accident deprived Illinois of one of her most useful citizens, and myself of a lamented and valued colleague. His mantle fell upon Dr. Wm. Le Baron, of Geneva—a gentleman of ripe knowledge, and whose work is highly appreciated. The value

placed on the entomological work that is being done in the Mississippi Valley may be partly inferred from the constant references to it at the meetings of our horticultural societies, farmers' clubs, and in the agricultural papers; but only those who have had opportunity can properly judge of the sympathy and encouragement constantly tendered by private parties who have been pecuniarily benefited by the reports made to the States mentioned.

The producers of Michigan, Indiana, Iowa, Wisconsin and Kansas are all taking steps to get the office of State Entomologist created, and bills to that effect are already pending in the Legislatures of some of these States.

Thus the good work proceeds! These States will, doubtless, in the end, succeed in following the example of Illinois and Missouri; for, in our broad and fertile valley, the voice of the tiller of the soil is now heeded in our legislative halls. Our agricultural interests demand protection from the numerous enemies which threaten them, and the indifference with which the farmers' requests have been listened to in the past is incompatible with that intelligence which should elevate his calling, and which is absolutely necessary to enable him to carry it on profitably. Nor is the day far distant when our agricultural colleges will awaken to the necessity of paying more attention to the subject. Nothing will so surely give to these colleges the distinctive character which their name implies, or prevent them from degenerating into ordinary institutions of learning, as increased attention to the applied sciences, of which Economic Entomology is by no means the least important. Already, courses of lectures on the subject have been given in Maine before the State College at Orono; in Kansas, before the college at Manhattan, and at Cornell University in New York; while Michigan Agricultural College has a chair of "Zoölogy and Economic Entomology," filled by Prof. A. C. Cook, already favorably known as a careful and conscientious investigator. I may also state that even in South America, applied entomology is appreciated, as Mr. B. P. Mann is now carrying on important labors as Entomologist to the Government of Brazil.

A virgin soil, enriched by the leafy mold of ages, and a harmonizing flora and fauna—the result of the long-continued struggle of each species for existence—gave to the early tiller of the soil in this country a rich reward with little labor; but at present he is beset with obstacles on every hand, and none but the well-informed are successful; for success in Agriculture and Horticulture, to-day, implies knowledge—scientific knowledge!

HOW TO COUNTERWORK NOXIOUS INSECTS.

Since, then, we sustain such immense loss from insect injuries, the question presents itself, how can we avert wholly, or in part, this great evil, and in what way are we to be benefited by the services

of one who makes it his especial duty to investigate the subject? There are two grand methods of counterworking a particular noxious insect: 1st, Prevention — i. e., guarding against the advent of the evil by proper foreknowledge, and prophylactic steps; 2d, Cure — i. e., the destruction of the pests, in one way or another, when once they are upon us. The last method consists of two distinct plans of action — that of killing directly by hand-picking, machinery, or the application of destructive substances to the plants or animals affected; and that of causing them to be killed by encouraging their natural enemies.

PREVENTION. — The first method — prevention — is by far the most satisfactory.

> The feathery snow-flake, on its ærial course,
> Is made, with ease, to vanish by a breath;
> To avalanche augmented, 'tis the source
> Of dire calamity — inevitable death.

It is an undeniable fact that many of the most troublesome weeds of American agriculture, as also some of its very worst insect enemies, have been imported among us from Europe; and the list of such species, given in my second report, might be greatly extended. The single case of the Rape Butterfly (*Pieris rapæ*) will serve to show how rapidly these foreigners multiply, and how injurious they become when unattended by the natural enemies which keep them in check in their native homes. Introduced at Quebec, Canada, in 1856, it has now spread over Canada West and most of the New England States, as far south as Baltimore, and nearing the eastern limit of New York. It sweeps the cabbage crop at all points it reaches, and caused, in 1871, a loss of $500,000 in the vicinity of New York City alone, if we are to believe the New York *Tribune*.

Now, there can not be the least doubt but that with the proper precautionary steps many of these immigrants from a foreign land need never have been introduced, or might have been stamped out, on first arrival, and kept from spreading over our fair country.

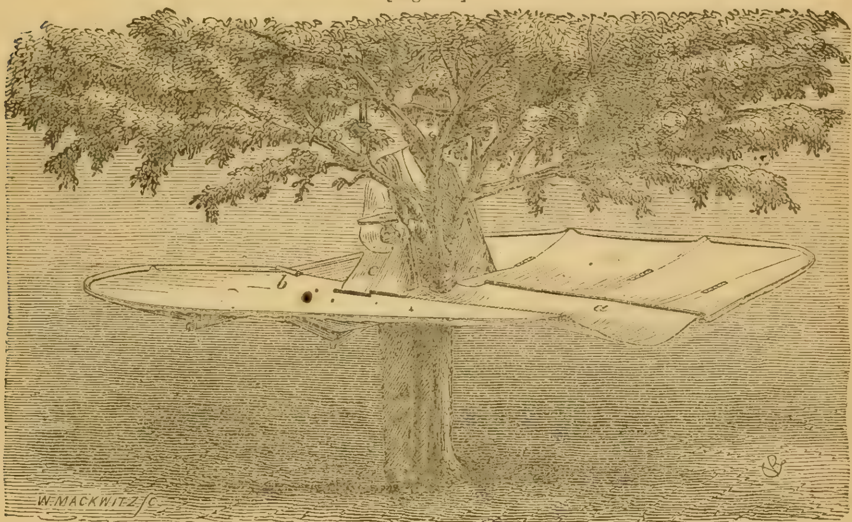
But insects not only spread from one country to another: they spread from State to State, from county to county, and from orchard to orchard; and in very many instances, this spread from place to place is very easily prevented, but unfortunately, just as easily, and more often, aided by man. Quite a number of our most noxious species would scarcely spread fifty miles in a century, were it not for the aid which man in his carelessness gives them. Some are active but a single day in the year; some move slowly under ground; some never quit the trees on which they are born; while still others are apterous in the female sex, and have otherwise very feeble ambulatory power.

In checking the spread of noxious insects does not consist the only way to prevent their injuries. We can also take advantage of their weak points, or nip the evil in the bud. Thus, when we know

that the parent Hessian-fly (*Cecidomyia destructor*) makes its first appearance in this latitude the fore part of September, and usually leaves by the end of the same month, we may avoid its injuries by deferring the planting of our grain till October. And if the parent Army-worm (*Leucania unipuncta*) deposits her eggs at the base of grass stalks in the fall of the year, we may avoid the ravages of her progeny by burning the stubble in the winter. A great many species which, like the Army-worm, are difficult to control in their other stages, are thus readily killed in the egg stage.

CURE.—The second method, namely, the cure of the evil when once it is upon us, is sometimes sufficiently easy; at others, almost, or quite, impossible. As already stated, we have here two distinct lines of action. That of killing the pests requires our ingenuity in the construction of mechanical devices, or our time and patience in the test and repeated trial of some external application that will kill the enemy, while it leaves the plant, or the animal, uninjured.

[Fig. 10.]



Here we learn the value of such contrivances as Dr. Hull's Curculio-catcher, (Fig. 10*), and the many modifications of it that have

* This is a modification of Dr. Hull's wheeling machine, (3d Rep. Fig. 2), which modification he used with good effect last summer, and which I described in the *Scientific American*, August 3, 1872, in the following terms:

"Dr. Hull was wont to claim that he could use his machine without injury to the trees, but the present modification of it is an evidence that experience has taught him differently. In all rolling machines, whether upon one or two wheels, when the bumping was not done by the machine itself, it had to be done by a long pole, tipped with rubber and used by a second person. But where I have used such a pole and separately jarred the larger boughs, the trees have been much injured in the course of a single year's work, and in some instances killed outright.

"The advantages of the present modification over the others may be thus briefly stated: It costs less, and enables the operator to get close to the tree, to which he can give a sudden jar with a hatchet or hammer. This is best done by striking a screw or spike previously inserted into the trunk, and purposely made with a shoulder so as to prevent driving; or by striking the end of a limb previously sawn squarely off. Such a hard, sudden jar, with an iron instrument, is far more effectual in bringing down the beetles than the more subdued bumping of a rubber mallet, as it is the sharpness and suddenness rather than the force of the blow which disturbs and alarms the little shy and cunning customers we have to deal with.

"The working of the machine is very well indicated in the illustration (Fig. 10). There is a bag, *d*, in the center, into which the operator can brush all fallen fruit, and a bottle of cheap alcohol may be kept in the vest pocket, into which the beetles should be thrown; or they may be simply crushed between the thumb and finger."

been used; here we see the importance of such applications as lime for slug-worms (genus *Selandria*) and other larvæ having soft, slimy skins; of white hellebore for the currant-worms (genus *Nematus*), and of some preparation having Paris Green as its base, for the Colorado Potato Beetle. As a rule, however, these methods of cure are far less satisfactory in their results than the modes of prevention, and should never be relied on when the latter can be resorted to.

That of causing them to be killed by encouraging their natural enemies, is one of the most effectual methods of counterworking noxious insects. Among such natural enemies, birds, toads, snakes and other reptiles hold a prominent place; and we have here to treat of the complicated bird question, or what may be termed ornithological entomology, which is yet in its infancy, and calls loudly for more attention. But the more important enemies of noxious insects are found in their own Class, and consist of the predaceous or cannibal and the parasitic species, wisely ordained to keep the others within due bounds.

To avail ourselves, in the fullest manner, of the aid of these friends, it is necessary, first, that by observation we discover what particular species prey on a particular vegetable-feeder; second, that by observation and experiment we determine the cheapest and most convenient method of spreading or propagating the species that so prey upon it; and if, as often happens, there are several such species, to determine which of them can be propagated most readily and cheaply.

In some cases we can do much to encourage the growth and distribution of our insect friends. Take, as an example, the imported Cabbage Butterfly already alluded to. In searching for insects in the winter time, in England and other parts of Europe, I recollect very well, when a lad, how common the naked and suspended chrysalides were along the ledges of palings, and in other sheltered situations; and how a large per centage of them were always parasitized, and generally distinguishable, in consequence, by their discolored look. Now, these could be collected by hundreds in winter time, shipped to this country, and the parasites allowed to escape in some cabbage-field infested with *Pieris rapæ*. The little Chalcid parasite of the Oyster-shell Bark-louse is easily introduced into "scurvy" orchards not yet favored with it, as I shall show in this Report. The parasites of the Plum Curculio (3d Rep. pp. 24–9), and those of the Codling moth, to be described further on, are easily bred and dispatched to parts where they are yet unknown. So of the enemy of the grape-leaf hoppers (3d Rep. p. 137), and of many others.

But practically, the propagation of a large proportion of parasitic and cannibal insects is beyond man's power; and all we can do is to protect and encourage them, as opportunity offers. To do so, it is very important that we know how to distinguish between our friends and

our foes, so as to avoid the blunders of one of Dr. Fitch's neighbors who complained that his currant bushes were suffering from plant-lice ten times worse than those of his neighbors, notwithstanding he took "the greatest pains every morning to kill off the old ones they breed from." Upon inquiry the Doctor ascertained that his worthy neighbor had busied himself in killing, not the aphides or plant-lice, but the ladybirds (*Coccinellidæ*) or plant-louse devourers that eat and drink plant-lice, have plant-lice for breakfast, dinner and supper, and are no more capable of breeding plant-lice than a lion is of breeding lambs.

It will be observed that in both these methods of fighting noxious insects — whether of prevention or cure — an accurate knowledge of the nature and of the habits of each particular species is absolutely necessary. It is the all-essential, the basis and groundwork on which every intelligent experiment must rest. *It therefore becomes the duty of the economic entomologist primarily to study and give to the world accurate accounts, with descriptions, of such insects, whether friends or foes, as more particularly concern the husbandman!*

DUTIES OF STATE ENTOMOLOGIST.

Many persons, not familiar with the facts here set forth, have no doubt wondered what can possibly be the duties of a State Entomologist; while in the minds of not a few the idea prevails that he is to catch and kill, or by some means rid the State of, all vermin. As if by the power of an Aaron's wand or the magic hest of a mighty Mulciber, he could perform the Augean task of clearing the land of insect plagues! It may not be amiss, therefore, to briefly define his duties.

Broadly speaking, insects are ten times as numerous in individuals and species as all other animals combined, and it is estimated that, on an average, there are five insects to one plant in any given area. From calculations which I have elsewhere made, (*Am. Ent.* II, p. 258,) it would require the entire working life of eighty-three persons, at a cost of one hundred and twenty-six million dollars, to describe and figure, in all four stages, the insects of the world. Insufficient as the estimate doubtless is, it will serve to convey some idea of the magnitude of the subject of entomology.

Where the field is so wide, the labors must be divided, and the comparatively few insects which particularly interest the producer are more than sufficient to occupy one man's time. The farmer, as a rule, has neither the means nor the opportunity to pursue the requisite studies; hence the wisdom of having a State officer for the purpose.

Such an officer should make an annual report, which should reflect the experience and observations of the year. Such a report, if well

made, is, necessarily, the result of much labor in the field, and close study in the closet, and should combine the practically useful with the scientifically accurate. It should be copiously illustrated, and the illustrations must generally be prepared from life by the author; for, strange as it may seem, there are few artists — however talented they may otherwise be—who can draft an insect with anatomical precision. Such a report, aside from its educational value, is of great material value to the State; but its usefulness will depend on the methods established by law for its distribution, as well as on the time of year of such distribution. In our own State it is bound in with the Agricultural Report, which is often a bulky volume, requiring a large amount of postage when sent through the mail; and I regret that there is not some provision of the law to have a small edition of the Entomological Report bound separately, to meet the demand that is constantly being made of me for the same.

The State Entomologist must, further, answer by letter or through the columns of different journals a host of queries that are continually pouring in upon him from correspondents. He should endeavor to protect the farmer from the impostors and quack nostrum venders who are ever ready to palm off their vile compounds upon the unsophisticated, as panaceas for all vegetable and animal ills. He must lecture; he must read a paper here and an essay there, whenever good can thus be accomplished. He must travel hither and thither over the State, to investigate the insects that are peculiar to different sections; he must carry on all sorts of experiments; but above all, he should employ every moment of time, not otherwise occupied, in ascertaining the habits and transformations of species.

These are the more ostensible duties of such an officer; but he has, in addition, to form a cabinet; and the collecting, the classification and arrangement, the proper determination of the species or description of such as are new—not to mention the manipulation necessary to prepare the specimens for such a cabinet—involve an amount of scientific detail and application, and of correspondence with scientific men throughout the civilized world, which few but those who have some insight into the life of a naturalist can appreciate.

Now, according to the means expended will be the results attained. There is a limit to one man's capabilities, and where the means are restricted, it often happens that only the independent enthusiast, who looks for other than mercenary reward, can afford to fill such a position if he wishes to do any good at all. His expenses for engraving, electrotyping and other illustrating material; for books, stationery, expressage and postage; for assistance, experiments and experimental material; for cabinets, chemicals and paraphernalia for collecting and preserving; for traveling, etc., must all come from a salary which in no instance has yet exceeded $3,000 per annum. The means are not at all commensurate with the vital interests at stake,

and I hope to live to see the day when there will be a corps of well-supported economic entomologists scattered through the country, instead of the few who are now in the field under crippled conditions. It is not well for our legislators to be penny wise and pound foolish in matters of this kind; and the office should be so endowed as to warrant at least the proper assistance. In my own capacity I have often felt cramped and restricted in my efforts; and experiments have frequently been valueless where, if they could have been carried out more thoroughly, they might have resulted in great good. An incomplete experiment is negative, and simply tantalizing, where a full and thorough one would be positive and definite, and might prove of the utmost importance.

HOW TO COLLECT, PRESERVE AND STUDY INSECTS.

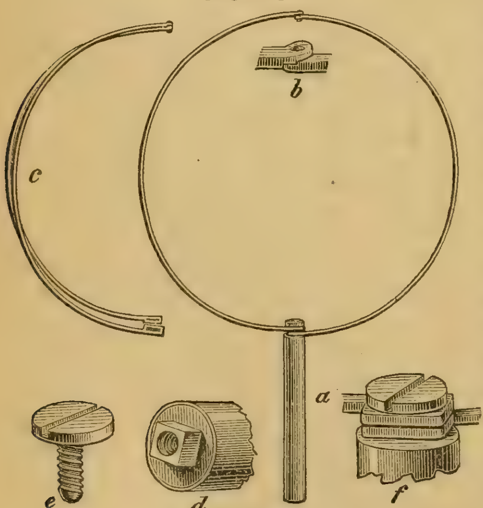
Few departments of natural history offer greater inducements or facilities to the student than Entomology. He need not pass his threshold for material, for it may be found on every hand and at all seasons. The directions for collecting, preserving and studying insects might be extended indefinitely in detail, as volumes have already been written on the subject; but the more general and important instructions are soon given.

Collecting.—Beginners are very apt to supply themselves with all sorts of appliances advertised by natural history furnishing-stores. Many of these appliances, when it comes to real, practical field-work, are soon abandoned as useless incumbrances; and the greater the experience, the simpler will be the paraphernalia. My own equipment, on a collecting trip, consists chiefly of a cotton umbrella, a strong and narrow steel trowel or digger, a haversack slung across the shoulders, a cigar-box lined with sheet cork, and a small knapsack attached to a waist-belt which girts a coat, not of many colors, but of many pockets so made that in stooping nothing falls out of them. The umbrella is one of the indispensables. It shields, when necessary, from old Sol's scorching rays and from the pelting, drenching storm; brings within reach, by its hooked handle, many a larva-freighted bough which would otherwise remain undisturbed; and forms an excellent receptacle for all insects that may be dislodged from bush or branch. Opened and held inverted under a bough with the left hand, while the right manipulates a beating-stick cut for the occasion, it will be the recipient of many a choice specimen that would never have been espied amid its protective surroundings. Some collectors use an umbrella painted or lined on the inside with white, to facilitate the detection of any object that drops into it; but as there are fully as many, if not more, pale and white insects as there are dark or black ones, the common dark umbrella is good enough for all ordinary purposes; and if any improvement on the ordinary cotton umbrella is

desired, it should be in the way of a joint or knuckle about the middle of the handle, which will facilitate its packing and using. The trowel is valuable for prying off the loosened bark from old trees, whether felled or standing, and for digging into the ground or into decaying stumps and logs. The haversack is for the carriage of different kinds of boxes (those made of tin being best) intended for larvæ and other forms which it is necessary to bring home alive for breeding purposes; and if made with a partition so that the filled and empty boxes may be separated, all the better: it may also be used for nets and other apparatus to be mentioned, and for such provender as is necessary on the trip. The knapsack may be made on the plan of a cartridge-box, of stout canvas or leather, and should be of moderate size and slung on to the belt so as to be slipped to any part of the waist and not hinder free bodily motion. It may be used to carry bottles, phials and many other small appliances, and should be accordingly partitioned and furnished with loops or pockets on the inside. The cigar-box is for the reception of pinned specimens, and may be slipped on to the belt, or buttoned to the pants, by means of leather.

The greatest requisites in collecting are a pair of sharp eyes and ready hands, with coolness and self-possession; but a few traps will materially aid. One of the most important is the hand-net, which may be made so as to subserve the two purposes of a sweeping and an air-net. The frame of the net which I use is illustrated herewith (Fig. 11), and will be found strong and serviceable and conveniently portable. It is constructed as follows: Take two pieces of stout brass wire, each about 20 inches long; bend them half-circularly and join at one end by a folding hinge having a check on one side (*b*). The other ends are bent and beaten into two square sockets (*f*) which fit to a nut sunk and soldered into one end of a brass tube (*d*). When so fitted, they are secured by a large-headed screw (*e*) threaded to fit into the nut-socket, and with a groove wide enough to receive the back of a common pocket knife-blade. The wire hoop is easily detached and folded, as at *c*, for convenient carriage; and the handle may be made of any desired length by cutting a stick and fitting it into the hollow tube *a*, which should be about six inches long. It is well to have two separate hoops—one of lighter wire fur-

[Fig. 11.]



nished with silk gauze or some other light material for catching flying insects; and one which is stouter and furnished with a net of stronger material for sweeping non-flying specimens.

Another still more simple, but less convenient, frame is thus described by my friend F. G. Sanborn, of Boston, Mass.:

[Fig. 12.]

"Make a loop of strong iron or brass wire, of about 3-16ths of an inch in thickness, so that the diameter of the loop or circle will not exceed twelve inches, leaving an inch to an inch and a half of wire at each end bent at nearly right angles. Bind the two extremities of the wire together with smaller wire (Fig. 12, *a*), and tin them by applying a drop of muriate of zinc, then holding it in the fire or over a gas flame until nearly red hot, when a few grains of block tin or soft solder placed upon them will flow evenly over the whole surface and join them firmly together. Take a Maynard rifle cartridge tube, or other brass tube of similar dimensions; if the former, file off the closed end or perforate it for the admission of the wire, and having tinned it in the same manner on the inside, push a tight-fitting cork half way through (Fig. 12, *c*) and pour into it melted tin or soft solder, and insert the wires; if carefully done, you will have a firmly constructed and very durable foundation for a collecting net. The cork being extracted, will leave a convenient socket for inserting a stick or walking cane to serve as a handle."

My friend, J. A. Lintner, of Albany, N. Y., makes very good use, in his ordinary promenades, of a telescopic fish-rod, with a head (Fig. 13.) screwed on to one end, in which to fasten an elastic brass coil on which the net is drawn, but which when not in use sets snugly inside his silk hat.

[Fig. 13.]

The bag should taper to the bottom, and in either case, should be fully twice the diameter of the hoop, so that by giving the net a twist, the mouth may be closed and the contents thus secured. The sweeping-net may be protected around the hoop with a covering of leather, and in use should be kept in a steady and continued back-and-forth motion, over and touching the plants, until the contents are to be examined; when, by placing the head at the opening and quietly surveying the restless inmates, the desiderata may be secured and the rest turned out. A sudden dash of the air-net will usually lay any flying object at the bottom. A net for aquatic insects may be made on the same principle, but should be stout, with the meshes open enough to allow free passage of water, and the bag not quite as deep as the diameter of the hoop. A forceps net, which consists of two gauze or bobbinet covered frames, having riveted handles, so as to close like a pair of scissors, is employed for small insects; but I find little use for it. A coarse sieve, together with a white towel, or sheet,

will be found of great service for special occasions, particularly in the spring, when the search for minute insects found under old leaves, or for pupæ around the butts of trees, is contemplated. With the sheet spread on the ground, and a few handfuls of leaves and leafy mold sifted over it, many a minute specimen will be separated from the coarser particles, and drop to the sheet, where the eye may readily detect it. Conversely, the earth taken from around trees may be sifted so as to leave in the sieve such larger objects as pupæ, etc. Another favorite plan, with some collectors, of obtaining specimens, especially night-flying moths, is by "sugaring." This consists of applying to the trunks of trees, or to strips of cloth attached to the trees, some sweet, attractive and stupefying preparation. Diluted molasses, or dissolved brown sugar, mixed with rum or beer, is most frequently employed. I have found sugaring of little use till after the blossoming season, and — notwithstanding assertions to the contrary — it is almost impossible to so stupefy or intoxicate an insect that it will remain till the next morning. I generally sugar at eve, and visit the tree several times between sundown and midnight, armed with wide-mouthed killing bottles, and accompanied by a second person who carries a dark-lantern. Isolated trees, on the edges of woods, give the best results. Everybody knows how some poor moths will persist in flitting round a light, until they singe their wings; and, as many insects are strongly attracted to bright artificial light, it may be employed with good results, especially during warm and damp evenings. The collector should never go unprovided with a small box or tube full of different sized pins (a corked cartridge tube makes a good box), a pair or two of forceps, a pair of scissors, a little mucilage, and the killing apparatus to be described.

KILLING.—After capturing an insect, intended for the cabinet, the next thing is to kill and dispose of it till one gets home. All those, as the various Beetles, Bugs, some Nerve-winged and some Straight-winged insects, which have either hard or naked coverings, and do not spoil when wetted, may be thrown into alcohol kept in stout, wide mouthed and well-corked bottles. The alcohol at once kills and preserves.

The cyanide bottle is very useful for killing the more delicate Scaly-winged and Two-winged insects. Itis a wide-mouthed bottle, with a few grains of cyanide of potassium kept in place at the bottom by a layer of cotton-wadding, pressed down upon it and capped with something smooth, such as perforated card-board. The cyanide is a deadly poison, and soon kills anything thrown into the bottle. Different sized bottles may be used, and one made of a chemist's test-tube (Fig. 14) is convenient in the field. Carbonate of ammonia may be used as a substitute for cyanide, but it affects the colors more, especially of delicate green insects. In countries

[Fig. 14.]

where the Laurel grows, its bruised leaves may be used in place of the cyanide; they kill less quickly, but have the advantage of safety. The leaves of the Laurel-Cherry, (*Prunus lauro-cerasus*), a plant commonly grown in England for screens and hedges, are also used for this purpose. A small and stout bottle of chloroform, or ether, with a brush securely inserted into the cork, (Fig. 15.), will be found very serviceable. A slight moistening through the air-net will stupefy most insects caught in it, and facilitate their removal to the cyanide bottle; while a touch or two with the wet brush under the head and thorax, will kill the more delicate specimens outright, without in the least injuring them. Another way of using chloroform is by means of a small, hollow tube passed through the cork (Fig. 16), what is called jeweler's hollow wire answering the purpose. The liquid evaporates more readily in such a bottle, and I altogether prefer the first mentioned. Some large insects, and especially female moths, whose size prevents the use of the ordinary cyanide bottles, are difficult to kill. With these, fluttering may be prevented by the use of chloroform, or by a squeeze of the thorax under the wings with the thumb and finger; and they may be killed by puncturing the thorax, or piercing the body longitudinally, with a needle dipped in liquid cyanide, or oxalic acid. A long bottle with a needle thrust into the cork may be kept for this purpose; but the needle must be of ivory or bone, as those of metal are corroded and eaten by the liquids. Hot water kills rapidly, and leaves the specimens in good flexible condition for mounting; the heads of large insects may be held for a few moments in the water, while smaller specimens should first be thrown into a corked bottle, and the bottle submitted to the heat.

[Fig. 15.]

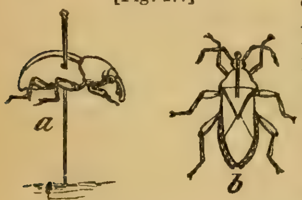
[Fig. 16.]

For killing small and delicate moths which have been bred, I find nothing more handy than chloroform. They may be caught in turned wooden boxes, which are kept by every druggist; and a touch of the chloroform on the outside of the box immediately stupefies them. It has a tendency to stiffen them, however, and they are best set immediately after death.

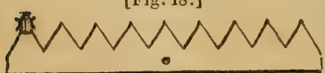
Some collectors, with indifferent olfactory sense, moisten the cork of their boxes with kreosote. Its killing power lasts for several days. A few whiffs from a cigar, when nothing else is at hand, will also kill many of the more tender insects.

Entomotaxy.—Unlike the ornithologist, the entomologist has no one word to express the preparing, setting and preserving of his specimens; but that used herewith will very well answer the purpose. In preparing insects for the cabinet, entomological pins, expressly made, should be used. Those manufactured by W. Klæger, of Berlin, are far superior to those of American make, and may be obtained through the agency of several of our Eastern natural history societies. They range, in number, from 00, or extremely fine, to 7, which is coarse and stout. Nos. 2, 3, 4, 5 and 6 are the most useful, and the others may, in reality, be dispensed with. French pins, ranging from 1 to 10, and over, the lower numbers finest, are next best, and may be had of John Akhurst, 19 Prospect street, Brooklyn, New York. All insects should be pinned through the middle of the thorax, where—as is more generally the case—this portion (*mesothorax*) is largely developed. Beetles (*Coleoptera*) and Bugs (*Hemiptera*) should, however, be pinned, the former through the right elytron or wing-cover, (Fig. 17, *a*), the latter through the scutel or triangular piece behind the thorax (Fig. 17, *b*), the pin issuing between the middle and hind legs. The specimens look very pretty with all the legs neatly spread out; but for practical purposes, it is usually as well to let them dry in the naturally folded positions: it is a saving of time, a saving of space, and the limbs are not so apt to break. There should always be about half an inch of the pin above the insect, to facilitate handling, and uniformity in this regard will have much to do with the neat appearance of a collection. Most insects which are too small to be pierced by a No. 2 pin may be fastened to card-board, by means of gum tragacanth. A drop of corrosive sublimate, added to the water with which the gum is diluted, will indefinitely prevent its souring, but should not be used where the gum is to come in contact with the pin, as it inclines the latter too much to verdigris. In such cases a little spirits of camphor mixed with the tragacanth is best. I have tried gum arabic with white sugar, as used by my late friend Walsh, French varnish, shellac dissolved in alcohol, and other gums; but much prefer the tragacanth. The card-board or Bristol-board may be cut into points or tags, of shape to suit the fancy. I use, myself, rows of wedge-shaped points (Fig. 18) of three different sizes, according to the insects to be fastened; and to facilitate the cutting of these rows, and to obtain uniformity, I have had three different sized stamps made, which prick the paper and indicate

[Fig. 17.]



[Fig. 18.]



each angle or corner. Delicate flies and moths which it will not do to fasten with mucilage, may first be mounted on very fine pins, (Nos. 19 and 20, made by Eddleston & Williams, Crown Court, Cheapside, London, are very fine and excellent,) or on silver wires, and these inserted into one end of little strips of cork or pith, through the other end of which a No. 3 or 4 Klæger pin passes to secure the specimen in the cabinet. Pith for this use should be dense, and that of Wormwood (*Artemisia*) or Mullein (*Verbascum*) will be found best. By this means the proper height is preserved, and the inconvenience and vexation of handling such very fine pins obviated. Some, who have plenty of time and patience to spare, throw their beetles into warm water, and, while all the parts are limp, fasten them by the legs on to card board coated with tragacanth, which, in drying, secures the beetle without discoloring the paper. The paper is afterward cut up into squares and pinned.

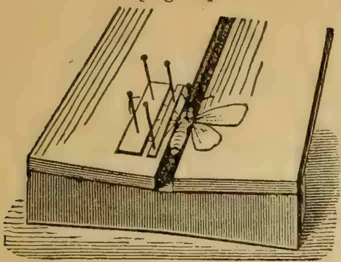
Many Coleopterists prefer to use separate slips of card-board, cut into isosceles triangles, crosswise on to the narrow tips of which the specimens are gummed with a cement of inspissated ox-gall, gum arabic and water, as recommended by Dr. LeConte; but, though more of the underside of the beetle is in this manner left exposed, I find my own method much the most convenient.

Many English entomologists use short pins; very much like those of ordinary make, and my late friend Walsh never gave up the custom, and most vehemently opposed the use of what he ridiculed as "long German skewers." But the only advantage that can possibly be claimed for the short pins is that they are less apt to bend, are consequently more easily stuck into the bottoms of boxes, and require less room; while, compared with the long pins, they have numerous disadvantages. Long pins admit of the very important advantage of attaching notes and labels to the specimen; render it more secure from injury when handled, and from museum pests in the cabinet; and on them several rows of carded duplicates may be fastened, one under the other, so as to economize room.

I have seen few old collections in better condition than that of M. E. Mulsant, of Lyons, France; and he uses iron wire, cut slantingly of the requisite length—a common custom in France. These wires bend so easily and have such dull points that they require much more careful manipulation than the pins, and the claim made for them that they do not verdigris, would, perhaps, not hold good near the sea. Silver wire, or silver-plated wire, is used for the same purpose.

For the proper setting of insects with broad and flattened wings, such as butterflies and moths, a spreading board or stretcher is necessary. One that is simple and answers every purpose is shown at figure 19. It may be made of two pieces of thin white-wood or pine board, fastened together by braces, especially at the ends, and left wide enough apart to admit the bodies of the insects to be spread: strips

[Fig. 19.]



of cork or pith, in which to fasten the pins, may then be tacked or glued below so as to cover the intervening space. The braces must be deep enough to prevent the pins from touching anything the stretcher may be laid on; and by attaching a ring or loop to one of them, the stretcher may be hung against a wall, out of the way. For ordinary-sized specimens I use boards 2 feet long, 3 inches wide and $\frac{1}{8}$ inch thick, with three braces (one in the middle and one at each end) $1\frac{1}{2}$ inches deep at the ends, but narrowing from each end to 1 1-6 inches at the middle. This slight rising from the middle is to counteract the tendency of the wings, however well dried, to drop a little after the insect is placed in the cabinet. The wings are held in position by means of strips of paper (Fig. 19) until dry. For stretching the wings, and for many other purposes, a handled needle will be found useful. Split off, with the grain, a piece of pine wood three or four inches long; hold it in the right hand; take a medium-sized needle in the left hand; hold it

[Fig. 20.]

upright with the point touching a walnut table, or other hard-grained wood, and bring a steady pressure to bear on the pine. The head of the needle will sink to any required distance into the pine, which may then be whittled off, and you have just the thing you want (Fig. 20). To obtain uniformity in the position of the wings, a good rule is to have the inner margins of the front wings as nearly as possible on a straight line (Fig. 19). When the specimens are thoroughly stiff and dry, they should be taken from the stretcher and kept for several weeks in the drying box before being permanently placed in the cabinet. The drying box is simply a box of any required dimensions, containing a series of shelves on which to pin the specimens, and without a solid back or front. The back is covered on the inside with fine gauze, and on the outside with coarser wire, and the door in front consists of a close-fitting frame of the same material—the object being to allow free passage of air, but at the same time to keep out dust and prevent the gnawings of mice and other animals. The shelves should be not less than two inches deep, and if made in the form of a quadrangular frame, braced with two cross-pieces on which to tack sheet cork, they will serve for the double purpose of drying spread specimens, and for the spreading of others; as there are many insects with long legs, which are more conveniently spread on such a board, by means of triangular pieces of stiff card-board braces or "saddles," than on the stretcher already described.

Two of these braces are fixed on the setting board, by means of stout pins, at sufficient distances apart to receive the body between them. The wings are then spread upon them and kept in place, until dry, by means of additional braces.

CABINET AND BOXES.—The boxes or cases, which are used to keep insects in permanently, may be made of any dimensions to suit the fancy—12x16 inches, inside, being a convenient size, and allowing economic use of cork. They must, however, be perfectly tight, and should not be more than $2\frac{1}{2}$ inches deep on the inside. The bottoms should be lined with something which will hold the pins, and the whole inside covered with white paper, which, if delicately cross-ruled, will facilitate the regular pinning of specimens. While the size and style of the box and cabinet may be left to individual taste, some choice must be had of material. *Red cedar should never be used.* I have learned, to my sorrow, the baneful effects of this wood, notwithstanding it is recommended—evidently by those who are guiltless of having used it—as having the advantage over other wood, of keeping off museum pests. It seems impossible to get this wood so seasoned but that a certain amount of resin will continually exude from it; and insects in boxes of this material are very apt to soften and become greasy. Paper boxes are also bad, as they attract moisture and cause the specimens to mold. The French used to make very neat boxes of this material, and Dr. Fitch, of New York, imported a number for his insects. He has been paid for his trouble by having almost all of his specimens ruined by mold. I use, myself, well seasoned pine and white-wood; and in such boxes as have glass covers, and are intended to form part of a neat cabinet for parlor ornament, the fronts may be of walnut or cherry.

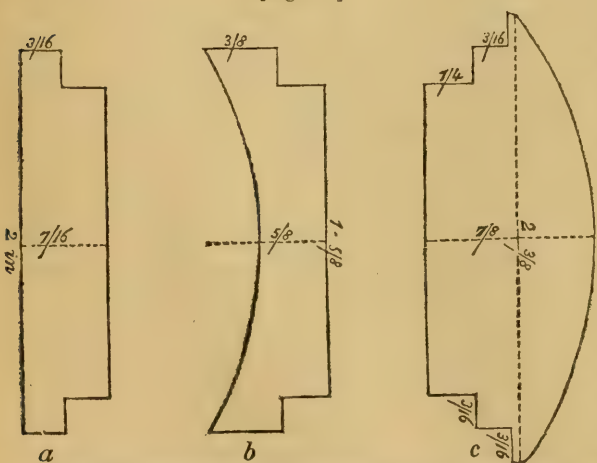
My best cabinet consists of 60 boxes of the above dimensions, in three tiers of twenty each. The boxes are made of well-seasoned pine, the lower part having a depth of $1\frac{1}{2}$ inches, with a rabbet extending $\frac{5}{8}$ inch above it. The glass cover, with a frame 1 inch deep, fits over this. The sides and back, exclusive of rabbet, are made of $\frac{1}{4}$ inch stuff, but the front, which is made of cherry, is twice as thick, the better to hold a ring, sunk flush in the middle. The bottoms are made of two thin pieces, cross-grained, to prevent warping or cracking, and the whole varnished with shellac and alcohol. The cabinet is made of black walnut, with the exception of the back, which is pine, and is simply a case with folding doors in front, and a series of skeleton shelves $\frac{5}{8}$ inch thick. Boxes, such as these, when the lid is secured by hooks, will also be found convenient to hang upon a wall.

A very convenient and secure box, $12x8x2\frac{1}{2}$ inches inside, and made to look like a book, is manufactured (price $3.00) by Mr. J. S. Ridings, of Philadelphia. The back is made in one piece, $12x3\frac{5}{8}$ inches, $\frac{1}{2}$ inch thick in the middle and rounding off on the outside to $\frac{1}{4}$ inch at the ends. The front and ends are 3 inches wide and $\frac{1}{4}$ inch thick, the front piece having a length of 12 and the ends, which overlap it, of $8\frac{1}{4}$ inches. The sides are $12\frac{5}{8}x8\frac{1}{2}$ inches, with a thickness of $\frac{1}{3}$ inch. When glued and bradded together, and sand-papered, this box is carefully sawed in two down the middle. Thin strips 2 inches wide and

⅜ thick are then cut in around one of the halves, so that the edges project and form a rabbet, which is beveled off and fits tightly against the inside of the other half when closed. The inside is lined with cork and paper, the back covered with stout linen or leather, which forms a hinge, and the whole either painted or papered to suit the fancy. It is neat, may be stood edgwise on a book-shelf, is easily handled, and is, withal, valuable to the working student, because new boxes may be added, in their proper places, as the collection increases; and the insects always kept in proper systematic order. Such boxes are also readily packed and moved from one place to another, and for this reason will commend themselves to the itinerant entomologist. Those who are ingenious, and have the proper tools, can make them at a less cost, but hardly with the same finish as does Mr. Ridings.

For beauty and security, and the perfect display of the larger *Lepidoptera*, I have seen nothing superior to a box used by Mr. Lintner, of Albany, N. Y. It is a frame made in the form of a folio volume, with glass set in for sides, and bound in an ordinary book cover. The insects are pinned onto pieces of cork, fastened to the inside of one of the glass plates; and the boxes may be stood on ends, in library shape, like ordinary books. For the benefit of those who wish to make small collections of showy insects, I give Mr. Lintner's method, of which he has been kind enough to furnish me the following description:

[Fig. 21.]



a *b* *c*

Figures *a*, *b* and *c* represent, in section, the framework of the volume—*a* showing the ends, *b* the front, and *c* the back. The material can be prepared in long strips of some soft wood, by a cabinet-maker, (if the collector has the necessary skill and leisure for framing it,) at a cost of sixty cents a frame, if a number sufficient for a dozen boxes be ordered. Or, if it be preferred to order them made, the cost should not exceed eighty cents each.

Before being placed in the hands of the binder, the mitering should be carefully examined, and any defect in fitting remedied, so that the glass, when placed in position, may have accurate bearings on all the sides. The interior of the frame is covered with tin-foil, made as smooth as possible before application, to be applied with thoroughly-boiled flour paste, (in which a small proportion of arsenic may be mixed), and rubbed smoothly down till the removal of the blisters, which are apt to appear. The tin-foil can be purchased, by weight, at druggists', and the sheets marked off and cut

by a rule in strips of proper width, allowing for a trifle of overlapping on the sides. Its cost per volume is merely nominal.

First quality single-thick glass for sides must be selected, wholly free from rust, veins, air-bubbles or any blemish. Such glass can be purchased at fifteen cents a pane. The lower glass, after thorough cleaning, especially of its inner surface, with an alkaline wash, and a final polishing with slightly wetted white printing paper, is to be firmly secured in its place by a proper number of tin points; the upper glass is but temporarily fastened. The binder must be directed to cover the exposed sides of the frame with "combed" paper, bringing it over the border of the permanent lower glass, and beneath the removable upper glass.

The covers of the volume are of heavy binder's-board (No. 18). neatly lined within with glazed white paper. On one of the insides of the lids may be attached, by its corners, a sheet with the numbers and names of the species contained in the volume, or these may be placed on the pin bearing the insect. If bound in best quality of imitation morocco, with cloth covers, lettered and gilded on the back, the cost (for a dozen volumes) need not exceed $1.00 each. If in turkey-morocco, it will be $1.50.

The lettering and ornamentation of the back will vary with the taste of the individual. The family designations may be permanently lettered, or they may be pasted on the back, on a slip of paper or gum-label, as are the generic names, thus permitting the change of the contents of a volume at any time, if desired.

The bits of cork to which the insects are to be pinned are cut in quarter-inch squares from sheet-cork of one-fourth of an inch in thickness. If the trouble be taken to trim off the corners, giving them an octagonal form, their appearance will be materially improved, and much less care will be required in adjusting them on the glass.

The cement usually recommended for attaching the cork to the glass is composed of equal parts of white wax and resin. My experience with this has not been favorable, for after the lapse of a few years, I have invariably been subjected to the serious annoyance of being compelled to renew the entire contents of the volume, clean the glass and replace the corks with new cement. From some cause, inexplicable to me, a gradual separation takes place of the cork with its cement from the glass, first appearing at the angles of the cork, and its progress indicated by an increasing number of iridescent rings which form within, until the centre is reached, when, if not previously detached, the insect falls with the cork, usually to its injury and that of others beneath it.

A number of years ago, I happened to employ, in attaching a single piece of cork in one of my cases, a cement originally made for other purposes, consisting of six parts of resin, one of wax and one of Venetian red. Several years thereafter, my attention was drawn to this piece, by finding it as firmly united as when at first applied, and at the present time (after the lapse of twelve years) it is without the slightest indication of separation. Acting upon this hint, I have, of late, used this cement in the restoration of a number of my cases, and with the most satisfactory results. It is important that the cement, when used, should be heated (by a spirit lamp or gas flame) to as high a degree as it will bear without burning. An amount sufficient to cover the bottom of the small, flat metal vessel containing it to the depth of an eighth of an inch will suffice, and prevent the cork from taking up more than its requisite quantity. It should be occasionally stirred to prevent the precipitation of its heavier portions. The cork may be conveniently dipped by the aid of a needle inserted in a handle, when, as quickly as possible, it should be transferred to the glass, for the degree of adhesion seems to depend upon the degree of fluidity of the cement. From some experiments made by me, after the corks had been attached as above, in heating the entire glass to such a degree as thoroughly to melt the cement until it spreads outward from beneath the weight of the cork, and then permitted to cool—the glass meanwhile held horizontally, that the corks might not be displaced—the results appear to indicate that the above cement, applied in this manner on glass properly cleaned, will prove a *permanent* one. It is scarcely necessary to state that this method is not available where the glass has been bound as above.

Preparatory to corking the glass for the specimens assigned to it, the spaces required for them are to be ascertained by arranging them in order on a cork surface, or otherwise. On a sheet of paper of the size of the glass, perpendicular lines, of the number of the rows and at their proper distances, are to be drawn, and cross lines equal in number to the insects contained in the rows. The distances of these lines will be uniform, unless smaller specimens are to occupy some portion of the case, when they may be graduated to the required proportion. With the sheet ruled in this manner and placed beneath the glass, the points where the corks are to be applied are indicated by the intersections of the lines. The sheet, marked with the family of the insects for which it was used, and with the numbers designating its divisions, may be laid aside for future use in the preparation of other cases for which it may be suitable. In a series of unbound cases in my collection, in which the glasses measure 11x14½ inches, I have used for my Lepidoptera and lain aside the following scales, the citation of which will also serve to show the capacity of the cases: 3x8, Catocalas; 2x7 and 3x9, Sphingidæ; 4x11 to 4x14, Bombycidæ; 5x13 to 6x16, Noctuidæ; 8x16 and 8x20, Lycænidæ and Tortricidæ.

The unbound cases above referred to are inexpensive frames, made by myself, of quarter-inch white wood or pine, the corners mitred, glued and nailed with ¾ inch brads, lined within with white paper, (better with tin-foil), and covered without with stout manilla paper. The glasses are cut of the size of the frame, and when placed in position thereon, are appressed closely to it by laying upon them, near each corner, a heavy weight, and strips of an enameled green paper, cut to the width of one inch, are pasted over their edges, extending a little beyond the thickness of the frame, and brought downward over the outside of the frame. On its back, two gum labels, indicating the insects inclosed, are placed at uniform heights (seven and twelve inches), when, if all has been neatly done, they present a tasteful appearance upon a shelf. When there is reason to believe that the case will need to be opened for the change or addition of specimens, it will be found convenient to employ, for the fastening of the left-hand side of the upper glass, paper lined with a thin muslin, to serve as a hinge when the other sides have been cut.

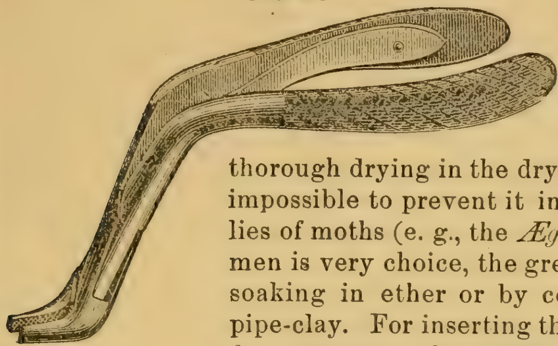
Should it become desirable to bind these cases, outside frames may be constructed after the plans above given, with the omission of the inside quarter-inch, (the equivalent of these frames), in which these may be placed and held in position by two or three screws inserted in their sides.

A similar case, used by Mr. Titian Peale of Washington, is described by Dr. Brackenridge Clemens (Smithsonian Rep., 1858, p. 196).

To hold the pins, various substances may be used, but nothing surpasses cork. It may be obtained in sheets, 12x3½x¼ inches, made expressly. It is for sale by several parties in the East, and is advertised by the Naturalists' Agency, Salem, Mass., and by Mr. Akhurst. The pith of Elder, Broom corn or Indian corn may be used by those who have time to properly cut it into uniform and square pieces; but it should first be boiled to extract the saccharine matter it contains, and afterward very thoroughly dried; otherwise it will corrode the pins. Boiler felt, properly split, has the advantage of cheapness, and is valuable. Where none of these materials can be obtained, two sheets of stiff paper, stretched on each side of a frame ¼ of an inch deep, and supported on a ledge of the same depth, may be fastened into the bottom of the box; and even bog peat, or a couple of thicknesses of blanket, will serve a good purpose. All these linings may be dispensed with in an emergency, and the pins stuck into the soft wood, especially if cut across the grain: i. e., horizontally from the tree.

A collection well mounted and cared for will last indefinitely. It must be kept from the light, which fades the specimens, and by all means from dampness. The preserved insects, if not constantly cared for and watched, will soon be injured or devoured by mites, *Psoci*, *Dermestes*, and other museum pests, against which there is nothing so effectual as vigilance. A little camphor kept in the boxes will assist in preserving the collection from these enemies; but it should not be used too freely, as I incline to think it has something to do in causing the specimens to grease. The best preventive of greasing is thorough drying in the drying box; but it is almost impossible to prevent it in the males of some families of moths (e. g., the *Ægeridæ*). When the specimen is very choice, the grease may be extracted by soaking in ether or by covering with pulverized pipe-clay. For inserting the more delicate pins, and for numerous other necessary operations, different forceps, and especially those shown in figures 22, 23 and 24, will be found invaluable.

[Fig. 22.]



If the paper in the bottoms of the boxes becomes yellow with age, or soiled in any way, it may be cleansed and whitened by a painting of very finely ground white zinc dissolved in isinglass or milk, and put on with a broad brush. A little corrosive sublimate worked in with the paint will serve to protect the insects.

[Fig. 23.]

[Fig. 24.]

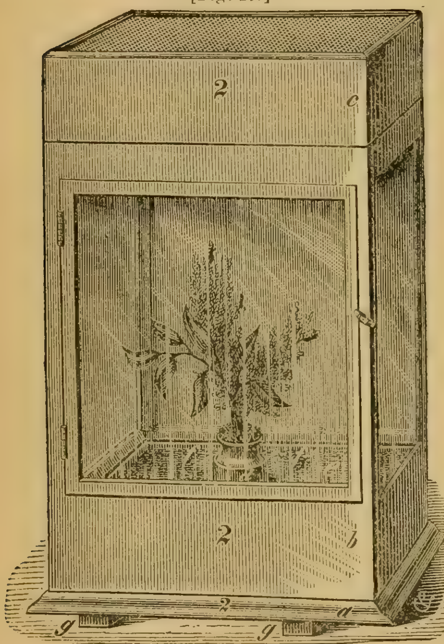
RELAXING.—Specimens which have become stiff before being spread, or which need resetting, may be relaxed by placing them in a tight tin vessel, half filled with moist sand; and a little carbolic acid in the moistening will prevent molding.

BREEDING.—Far too little attention has been given by entomologists in this country to the breeding or rearing of insects, notwithstanding it offers a greater field for usefulness, and for original observation, than any other special branch of the science.

Insects are by no means difficult to rear, and there is a genuine pleasure in watching their transformations, and in the anticipation and expectancy with which one looks forward to the ultimate form of some new or unfamiliar larva. If it is gratifying to be able to properly determine and classify a species, it is still more so to be acquainted with it in all its forms, and to understand its curious habits and ways of life.

In the hands of the careful breeder, an insect may be secured against its numerous natural enemies, and against vicissitudes of climate; and will consequently be more apt to mature than in a state of nature. Yet the great secret of successful breeding lies in otherwise supplying, as far as possible, the natural conditions. The breeding of aquatic insects requires properly arranged aquaria, and is always attended with the difficulty of furnishing a proper supply of food. The transformations of many others, both aquatic and terrestrial, can only be studied by close and careful out-door observation. But the great majority of insect larvæ may be reared to the perfect state indoors, where their manœuverings may be constantly and conveniently watched. For the feeding of small species, glass jars and wide-mouthed bottles will be found useful. The mouths should be covered with gauze or old linen, fastened either by thread or rubber; and a few inches of moist earth at the bottom will furnish a retreat for those which enter it to transform, and keep the atmosphere in a moist and fit condition.

[Fig. 25.]



For larger insects I use a breeding cage or vivarium of my own devising, and which answers the purpose admirably. It is represented in figure 25, and comprises three distinct parts: 1st, the bottom board (*a*), consisting of a square piece of inch-thick walnut with a rectangular zinc pan (*ff*), 4 inches deep, fastened to it, above, and with two cross pieces (*gg*) below, to prevent cracking or warping, facilitate lifting, and allow the air to pass underneath the cage. 2d, a box (*b*), with three glass sides and a glass door in front, to fit over the zinc pan. 3d, a cap (*c*), which fits closely on to the box, and has a top of fine wire gauze. To the center of the zinc pan is soldered a zinc tube (*d*) just large enough to contain an ordinary quinine bottle. The zinc pan is filled with clean sifted earth or sand (*e*), and the quinine bottle is for the reception of the food-plant. The cage admits of abundant light and air, and also of the easy removal of excrement and frass which falls to the ground; while the insects in transforming enter the ground or attach themselves to the sides or the cap, according to their habits. The most convenient dimensions I find to be 12 inches square and 18 inches

high: the cap and the door fit closely by means of rabbets, and the former has a depth of about 4 inches to admit of the largest cocoon being spun in it without touching the box on which it rests. The zinc pan might be made 6 or 8 inches deep, and the lower half filled with sand, so as to keep the whole moist for a greater length of time.

A dozen such cages will furnish room for the annual breeding of a great number of species, as several having different habits and appearance, and which there is no danger of confounding, may be simultaneously fed in the same cage. I number each of the three parts of each cage to prevent misplacement and to facilitate reference, and aside from the notes made in the note-book, it will aid the memory, and expedite matters, to keep a short open record of the species contained in each cage, by means of slips of paper pasted on to the glass door. As fast as the different specimens complete their transformations and are taken from the cage, the notes may be altered or erased, or the slips wetted and removed entirely. To prevent possible confounding of the different species which enter the ground, it is well, from time to time, to sift the earth, separate the pupæ and place them in what I call "imago cages," used for this purpose alone and not for feeding. Here they may be arranged, with references to their exact whereabouts.

A continued supply of *fresh* food must be given to those insects which are feeding, and a bit of moist sponge thrust into the mouth of the bottle will prevent drowning, and furnish moisture to such as need it. By means of a broad paste-brush and spoon the frass may be daily removed from the earth, which should, by sprinkling, be kept in a fit and moist condition—neither too wet nor too dry. In the winter, when insect life is dormant, the earth may be covered with a layer of clean moss, and the cages put away in the cellar, where they will need only occasional inspection, but where the moss must nevertheless be kept damp. Cages made after the same plan, but with the sides of wire gauze instead of glass, may be used for insects which do not well bear confinement indoors, the cages to be placed on a platform on the north side of a house, where they will receive only the early morning and late evening sun.

Such are a few directions, of a most general nature, for those wishing to commence to collect and study insects. Experience will teach a hundred others here unmentioned, and the best closing advice which I can give to the novice is to get acquainted, if possible, with some one who already has that experience. You will find him pleasant and instructive company—whether in the field or the closet.

NOTES.—The collector should never be without his note-book, for more profitless work can scarcely be imagined than the collecting of natural history specimens without some aim—some object. Every observation, carefully made, should be recorded, and the date of capture, locality, food-plant, and such minor notes should be attached to

the specimen. More extended notes should be made in a permanent memorandum-book, under numbers corresponding to those attached to the specimens mounted or being reared.

How to transmit Insects.—Insects about whose habits information is desired, should, whenever possible, be sent alive. Larvæ should be packed in some light tin box, along with a supply of their appropriate food-plant. The tighter the box, the fresher will the food, as well as the specimens, keep. Insects do not suffocate so quickly as human beings, and it is worse than useless, in the majority of cases, to punch air-holes in such boxes. Dead specimens may be sent in a variety of ways. Small ones may be dropped into a quill, and inclosed in a letter, or in a small phial, fitted into a piece of bored wood. Those which do not spoil by wetting may be sent in alcohol, or in saw-dust moistened with alcohol. Mounted specimens should always be pinned securely in a cork-lined box, and this packed in a somewhat larger one, with cotton-wadding, or some other yielding substance, in the intervening space, to obviate jarring, and insure safe carriage. When more than one specimen is sent, they should always be numbered. Packages, not exceeding twelve ounces, tied with string, so that they may be examined, and marked "samples," may be sent by mail, at the rate of one cent for two ounces, under the present postal rules.

Text-Books.—The only text-book worthy of the name in this country, is Packard's "Guide to the Study of Insects," already referred to—a work which every entomologist should possess. For the novice, Harris's "Insects Injurious to Vegetation," will prove more pleasant and instructive, and he should read Kirby and Spence's "Introduction." Westwood's "Introduction," although published thirty years ago, is indispensable. The reports of the different States should be consulted, and especially those of New York. These are a few of the more important works, but the number might be greatly multiplied. There is no better text-book, however, than that which lies open before us on every hand—the great text-book prepared for our reading by the Creator. There it is, ready to unfold the great truths it contains, to all who earnestly seek them. I would not decry or depreciate text-books, although—in this country more especially—there are so many inferior and so few good ones; but the student who confines himself too much to them, is apt to get his originality dwarfed, and to become the mere mouth-piece for others' thoughts. By original study and investigation, one escapes from the thraldom of mere words, and we should remember that, as Huxley appropriately remarks, "the study of things and not of words is the source of true knowledge;" and that "there is a world of facts outside and beyond the world of words." In libraries and museums, the entomologist may find the dry bones of knowledge; but only in Nature's own

museum can he clothe those dry bones with beauty and life. Let him, then, go forth into field and wood, where alone he can receive that rapturous inspiration, and experience that unutterable admiration and awe, caused by the mysterious animating force around and about him, and which sends zeal and strength thrilling through every fibre of the earnest naturalist — where,

> Meeting him at every gaze,
> New truths give pleasure and amaze!

NOXIOUS INSECTS.

NOTES OF THE YEAR.

Of the more prominent and important of our insect enemies prolonged experience is continually teaching us something new, and of some of those already treated of in former Reports, I shall, each year, under the head of "Notes of the Year," bring together such additional facts and discoveries as are worthy of being recorded. These notes are therefore intended to supplement the original articles, and I shall endeavor to avoid anything like repetition of what has already appeared. By thus adding the observations of the year, the original reports will be rendered more complete and circumspect.

THE CODLING MOTH.

The first moth was bred this year, from larvæ which had wintered out-doors, on May 7th, and the first one captured, at large, May 14th. The experience of the year is of importance, more especially as giving a confirmed estimate of the value of

WIER'S APPLE-WORM TRAP.

Fully resolved to test this trap thoroughly, in comparison with other methods of allurement, I commenced (having, of course, purchased the right to use!) as early as the first of May to prepare a number of trees as follows: 1st. With Wier's trap screwed on in different positions — some trees having single traps, either on the north, south, east or west sides, and placed at different heights from the ground, and some having as many as three traps; 2d. Strips of old sacks, four inches wide, and lined on one side with pieces of lath tacked on transversely, and at such distance from each other that, when brought around the tree, they formed an almost complete wooden

ring; 3d. Bandages of various kinds of rag; 4th. Hay ropes; 5th. Paper bandages, made of the cheapest kind of straw paper, folded several times, and in widths varying from three to six inches. In order to insure the utmost accuracy, these several traps were regularly examined every twelve days throughout the season, and a careful account kept of the worms or chrysalides found under each; and where it was a question as to the comparative merits of the different traps, they were placed on trees of the same variety. The results of these experiments—not to waste space with the detailed array of figures—may be thus summed up:

No apple-worms were found until the 14th of June, and, though many other insects had previously taken advantage of the shelter, *not a single Plum Curculio was found.* While, therefore, there is no harm in having the bandages on as early as recommended last year, in ordinary seasons, little, if anything, will be lost by waiting till the first of June. Where three of the Wier traps were on the same tree, I obtained more worms than where there was but one; and where there was but one, there was no difference in favor of position, as regards direction or altitude—taking the season through. The lathed canvas encircling the tree secured, on an average, five times as many worms as any single Wier trap. The rag, paper and hay bandages allured almost as many, and either kind more than the single Wier trap.

I hope, therefore, that the patentees have already realized the anticipated fortune from their invention; for while I should be sorry to injure their chances in the least, truth compels me to state that, after a year's trial, I am not quite as favorably impressed with the usefulness of this shingle-trap as I was before trial, and am more thoroughly confirmed in the opinion expressed last year that, "notwithstanding all the theories of my friend Wier, it must always be inferior to any trap that encircles the tree." I do not wish to detract from its merits one jot, and where old shingles are abundant and other material scarce, the former will still prove valuable for the reasons given a year ago; and Mr. Wier would deserve our thanks for showing us how to use them, did he not persist in claiming too much for them, and in making us pay for their use.

Time, expense and efficiency considered, and so far as one year's comparison will warrant conclusions, I place the different materials enumerated in the following order of merit:

1.—Paper bandages. Common straw wrapping paper, 18x30, can be bought for sixty cents per bundle. Each bundle contains 240 sheets, and each sheet folded lengthwise thrice upon itself, will give us eight layers, between two and three inches wide, and be of sufficient length to encircle most ordinary trees. It is easily drawn around the tree and fastened with a tack, and so cheap that when the time comes to destroy the worms, the bandages containing them may be

detached, piled in a heap and burned, and new ones attached in their places. If eight bandages are used to each tree during the season, the cost will be just two cents per tree; and the owner could well afford to treble the number of sheets, and keep three on each tree, either together or in different places.

2.—Rags. These have very much the same effect as paper, but are more costly and difficult to get of the requisite length. Where they can be had cheaply, they may be detached from the tree and scalded with their contents.

3.—The Wier-trap, used as recommended last year, is, perhaps, the next most useful; but both cost and time required to destroy the worms, are greater than in the first two methods.

4.—The lath-belt is the very best of all traps, so far as efficiency goes; but it is placed 4th on the list, because of the greater cost and trouble of making. On the same kinds of tree, (Early Harvest), and in the same orchard, I have taken, with this belt, between June 15th and July 1st, as many as 68, and 99 larvæ and pupæ, against 14 and 20 in the single Wier-trap.

5.—Hay-bands, on account of their greater inconvenience, I place last.

The experiments were mostly made in a large and rather neglected orchard, belonging to Mrs. Spencer Smith.

All these methods are good, and the orchardist will be guided in his choice by individual circumstances.

JARRING.

Regarding this plan, I reproduce the following item, which I sent to the *Country Gentleman* last summer:

"Being much pleased with Mr. Chapin's method of freeing his orchard of apple-worms, as described in your issue for January 25th, I inserted a description of his process in my fourth Report, with a few comments as to the time when the jarring should be commenced. Mr. Chapin commences when the little brown masses of excrements are first observed on the outside of the apples, generally near the blossom end. As these masses of excrement — these "exudations," as Mr. Chapin terms them—are usually sure signs that the worm has already left the fruit, it struck me that jarring should commence somewhat earlier, and I suggested the first rather than the middle of July. But I find this spring that this excrement is only an indication of the worm's exit, with some varieties, while with others the worm may be often found after these exudations are visible. In justice to Mr. Chapin, I take the first opportunity to make the correction. Our blossoming season, in this latitude, was nearly two weeks later than usual, and I caught the first worms, under bandages, on the 13th of June."

To prevent bruising of the branches, it will be well, as suggested by Mr. J. Fitz, of Albemarle county, Virginia, (*Country Gentleman*, August 2), to use a light pole, with a short fork, padded with some soft material at one end. This can be jarred by means of a mallet.

As confirmatory of the fact that the Apple-worm

ATTACKS PEACHES,

I last fall received specimens of this fruit, infested with it, from Geo. T. Anthony, of the *Kansas Farmer*.

ALREADY FOUND IN CALIFORNIA.

There were several reports, during the last year, that this insect has been noticed in California; though how truthful they are, I have no means of ascertaining.

NATURAL ENEMIES—DISCOVERY OF TWO PARASITES.

In addition to the two cannibal larvæ which I have described as feeding on the Apple-worm, I can now add two genuine parasites to the list of its enemies. If we except a species of hair-snake, belonging probably to the genus *Mermis*, and which Mr. P. H. Foster, of Babylon, New York, has found on two occasions infesting it,* no true parasite of the Apple-worm has ever been discovered in this country. I have the past year discovered two. Both of them are Ichneumon-flies, and the first may be called

[Fig. 26.]

THE RING-LEGGED PIMPLA (*Pimpla annulipes* Br.)—This is a black fly, varying considerably in size, the female sometimes measuring but ¼, at others fully ½ inch, exclusive of ovipositor; the male somewhat smaller. The genus *Pimpla* was briefly characterized in my last Report, (p. 43), where it was shown that this same species attacks the Walnut Case-bearer (*Acrobasis juglandis* LeB.) I annex a lateral outline of a female *Pimpla* (Fig. 26). The male has a more slender abdomen, which is unarmed.

PIMPLA ANNULIPES is black; the abdomen rough-punctured above, with the borders of the joints polished and inclined to brown. The tegulæ are white, and the legs are reddish, with the exception of the middle and hind tibiæ, which are dusky—especially the hind pair—and have a broad white annulus, sometimes indistinct on the middle pair. The posterior tarsi are dusky, especially at tip. The palpi are pale-yellow. Cresson says it may be distinguished from the other species of the genus, by the scutellum being black, the tegulæ white, and the anterior coxæ yellowish-red.

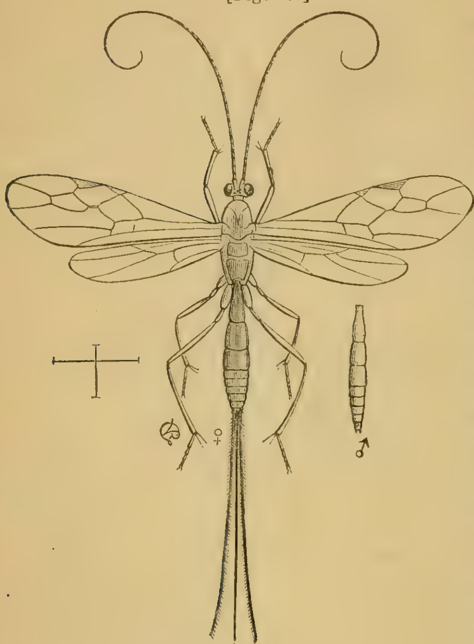
This fly eats its way through the chrysalis and cocoon of the Codling-moth, without having previously made any cocoon of its own. It

Gardeners' Monthly, May, 1872.

was quite abundant last summer, as from one lot of 162 *Carpocapsa* cocoons I obtained 21 parasites—all of them females but one. It is a widely distributed, and common species. The second parasite may be called the

DELICATE LONG-STING (*Macrocentrus delicatus* Cress.).—It has recently been described by Mr. E. T. Cresson, (Transactions Am. Ent. Soc., IV, p. 178), and is a somewhat variable species, occurring throughout the Eastern, Middle and Western States, and in Mexico I subjoin a description, drawn up from my bred specimens:

[Fig. 27.]



♂—Length 0.25; expanse 0.45 inch. Slender. Color pale, polished, honey-yellow; uniformly and sparsely pubescent; tinged with brown superiorly, the basal joint of abdomen and a medio-dorsal line on the other joints being quite brown. *Head*, with the eyes, (except at disc), and a spot between ocelli, brown-black; palpi long and almost white; antennæ ¼ longer than the whole body, about 48-joints, exclusive of bulbus, curled at tip, the ends of basal joints and the whole of apical joints dusky. *Thorax*, with the sutures well defined, and two small triangular black spots behind front tegulæ, the metathorax strongly trilobed; legs very long, pale honey-yellow, with tips of tibiæ and tarsi faintly dusky; wings yellowish, hyaline and iridescent, with the veins luteous, and the stigma pale honey-yellow.

♀—Rather larger, and with the abdomen somewhat paler, otherwise similarly marked. Ovipositor yellow, 1-5 longer than body, the sheaths quite pilose, and inclining to fuscous.

Described from 2 ♀'s, 1 ♂.

It is a graceful fly, with very long antennæ and legs, and the female with a long ovipositor (Fig. 27). The color is pale honey-yellow, inclining to brown above. The unfortunate Apple-worm is probably pierced while yet in the fruit, as it always succumbs soon after forming its cocoon, and before changing to chrysalis; while in the case of *Pimpla*, it is probably attacked either while leaving the fruit or after having spun its cocoon. The larva of the Delicate Long-sting forms, for itself, within the cocoon of its victim, a sufficiently tough, thin, oblong-oval, shiny, brown cocoon, from which the perfect fly issues by cutting open a lid at one end.

As both of these parasites transform within the *Carpocapsa* cocoon, it is next to impossible, and quite impracticable, to separate friend from foe in removing and destroying the contents of the band-

ages. But where it is desired to disseminate the parasites, they may be bred by inclosing large numbers of *Carpocapsa* cocoons in some tight vessel. The apple crop was abundant, and the Codling-moth comparatively harmless in most parts of the country the past year, though whether or not this abundance was in any way connected with the work of these parasites, it is useless to speculate.

The *Pimplas* were, most of them, bred from cocoons taken from the lathed bandages, and the spaces between the pieces of lath may have more easily permitted the access of the Ichneumon-fly than was the case with some of the other bandages.

Besides these parasites, and enemies previously alluded to, I found that ants, cockroaches, and the larvæ of certain predaceous beetles,* played by no means an unimportant part in destroying the apple worms.†

FALSE DOCTRINES.

An apparently plausible method of eradication has been proposed by Dr. J. S. Parker, of Ithaca, N. Y. In an article in the *Maine Far-*

* The larva of some species of *Trogosita*, and closely resembling that from which I have bred *Trogosita nana* Melsh., was frequently found at this work.

† While this is going through the printer's hands, I notice that Dr. LeBaron has made similar and corroborative observations regarding a *Trogosita* larva (*Prairie Farmer*, April 12, 1873). He also publishes the following communication from Mr. G. W. Shaw, of Decatur county, Iowa:

In the spring of 1870, I planted among my currants the Early Goodrich potatoes. Currants were six by six feet apart. When the potatoes were fairly up, the Colorado potato beetle commenced upon them. I tried hand-picking, and for the first time became acquainted with the soldier-bug, seeing him spear the young potato beetles. The next spring, 1871, the currant bushes were alive with the currant worm. It seemed almost useless to try and pick them off. I commenced, however, and the second day was rewarded by seeing the soldier-bug spearing them, and in a few days not a currant worm was to be seen. This season the codling moth, or apple worm as it is called, was very bad in my orchard; nearly every apple had a worm in it. I noticed very many of the soldier-bugs on the trees. They would pass up and down the branches, and when they came to an apple would go down to the blossom end and stick their bill into the calyx of the apple, and remain as long as five minutes, as I then thought, sucking the juice out of the apple. In June, 1872, I saw a soldier-bug sucking an Early Harvest apple, and watched him for some minutes. When he was through, he folded his bill under his body and moved to another apple, and what was my surprise to see the skin of an apple worm on the blossom end of the apple that he had just left. It seemed very strange to me that I had spent ten or twelve years in the orchards and had never known before what the soldier-bug was after. Frequently after that I saw the beetle take the worms out. At other times, after cutting the apple open, the worm would be found dead. The part of the orchard near the currant plantation was much less affected by the codling moth than that farther off.

This is certainly a very interesting observation, but will need corroboration before being accepted. Mr. Shaw is evidently not much of an entomologist, else he would not use the term beetle in referring to a Heteropteron; and though this is nothing to be ashamed of, it renders us less ready to receive his conclusions as valid when we reflect on the following facts: 1. The beak of the Spined Soldier-bug (4th Rep., Fig. 9) is, at the most, not more than 1-5 inch long (I speak from memory) and I have never seen it inserted above the terminal joint. 2. It would, therefore, be of little service, except when the fruit is very small. 3. Until the apple-worm is nearly grown and the fruit has acquired some size, there is seldom any outward sign of the work of the worm, which enters by a very minute hole, and, for the most part, bores in the heart, around the core. 4. It could not be pulled out of such fruit by a haustellate bug, which can only penetrate and pierce, and not cut. 5. There are many other Half-wing bugs which few but the entomologist could distinguish from the Spined species in question, and which are vegetarian in habit, but occasionally suck the juices of soft-bodied larvæ. 6. There is another and smaller worm, namely, the larva of what Mr. Walsh called the Plum Moth (*Semasia prunivora* Walsh), which is quite common on haws and apples. It does not penetrate deeply into the apple, but remains around the calyx, and generally spins up there; and it so closely resembles the young apple-worm that the two might easily be confounded.

While, therefore, I do not doubt but that *Arma spinosa* would stab an apple worm if it got a chance, it will require better proof than we yet have to make me believe that it pulls this worm out of its hidden abode.

mer for June 1st, 1872, in which nine-tenths of all the apples set in 1871 are said to have been either totally lost or greatly damaged, he suggests that the insect might be well-nigh exterminated, if, by united effort, we could forego one year's crop, by knocking off all the young fruit. He fails to attach sufficient importance to the fact that the insect breeds in wild crabs, pears, peaches, and even plums.

THE COLORADO POTATO BEETLE.

One of the characteristic features of the past year was the comparative harmlessness of this insect. What with the increase of its enemies, and the thinning out in its ranks which took place the previous year, it did comparatively little damage with us, though somewhat conspicuous early in the season in Phelps, Perry and other counties. The decrease in its numbers seems, also, to have been very general over our own country, as the newspapers were unusually free from reports of its injuries. In Ontario, it has increased and spread, though not to the extent anticipated.

NEW FOOD PLANTS.

Mr. J. D. Putnam, of Davenport, Iowa, who was out collecting in Colorado during the summer, reports having found the larvæ on Stickseed (*Echinospermum strictum*), common Pigweed (*Amaranthus retroflexus*), and a wild Sunflower (*Helianthus peteolaris*). These plants belong to three distinct families, and Mr. Putnam believes that the larvæ were feeding on them.

ITS PROGRESS EASTWARD.

In 1871, this insect had reached the western borders of Pennsylvania and New York. Last year it extended into Cattaraugus county, N. Y.,* and obtained a foot-hold as far east as Lancaster county, Pa. In July, my valued correspondent, Mr. S. S. Rathvon, informed me that it had reached that county, and in the Lancaster *Weekly Express* for July 6th, he gave a long account of it, urging vigilance in its destruction upon those who were being visited by it. From later accounts, there were no insects to be seen after the middle of Sep-

* *Rural New Yorker* for Aug. 3rd and Aug. 17th, 1872.

tember, and it is barely possible that, by being forewarned and forearmed, the farmers succeeded in eradicating the evil; especially if, as I believe, the arrival of the pest at a point so far east was premature and artificial. Had its appearance in Lancaster county been the result of its gradual spread, we should first have heard of it in the intervening western counties of the State, and it would have been beyond human power to stay its irresistible march. But all the evidence points to its transportation with some cargo, on the railroad.

The southern columns have extended somewhat east of Louisville in Kentucky, for they were abundant around Harrodsburgh, in Mercer county, as I learn from Jas. B. Clark, editor of the *People* of that place.

These are the only trustworthy records of its eastward progress which have come to my knowledge; for though other reports have been made, there is no more proof that some other insect was not mistaken for it than there is in the statement in the monthly report of the Department of Agriculture for July, that it was found in one county in each of the States of Virginia, North Carolina, Alabama and Tennessee—a statement evidently loose.

With regard to the safety of the

USE OF PARIS GREEN,

Prof. W. K. Kedzie, of the Michigan Agricultural College, has made some interesting experiments. In a paper read before the natural history society of the college, he showed how the green was insoluble in pure water, and that where water was charged with carbonic acid or ammonia, the very small portion that is dissolved is quickly converted into an insoluble precipitate with the oxide of iron which exists in our western soils. He shows just as conclusively that there would be great danger in using pure arsenic—even were it as effectual as the green—for the reason that it is soluble to such an extent that it could not be neutralized by the oxide of iron in the soil.

Prompted by the report from the Department of Agriculture, to the effect that peas planted in soil mixed with the green rotted immediately, I made the following experiment with peas and the mixture of one part green, twenty flour: I planted five rows of peas, using no green on the first, a little on the second, and increasing the amount on the others, so that on the fifth the peas had, in addition to that mixed with the soil, a covering of about one-eighth of an inch. The peas all grew and bloomed without noticeable difference, and were finally eaten by a cow.

NEW ENEMIES.

So little troublesome was this *Doryphora* in my own neighborhood, that, with other more pressing duties, I paid little attention

[Fig. 28.]

to it, and made few personal observations. But from facts communicated by Mrs. H. C. Freeman, of South Pass, Illinois, it is safe to add to its natural enemies the Rust-red Social Wasp (*Polistes rubiginosus* St. Farg.), which carries the larva to its nest.

Figure 28, *a* shows this wasp, and *b* the manner in which her spring nest is built.

In July, Prof. C. E. Bessey, of Iowa Agricultural College, wrote me word that he found the Rose-breasted Grosbeck, (*Guiraca ludoviciana*), devouring the potato beetles, and soon afterward, the same bird was sent to me by E. H. King, of Steamboat Rock, Iowa, with a similar statement. Other persons, especially in Iowa, observed the same trait in this bird, which, though formerly quite rare, seems to have suddenly multiplied and acquired this habit. Mr. Joel Barber, of Lancaster, Wisconsin, informed me that this bird, though seldom seen there before, was quite common in that vicinity about the first of June, breeding there, and clearing potatoes of the nasty "bugs," which it seemed to prefer to all other food.

The Rose-breasted Grosbeck is a beautiful and conspicuous bird, the male having a heavy bill, with black head, black back varied with brown, and black wings, the latter with three white bands. Some of the outer tail-feathers and parts of the abdomen are white, and the breast is rose-red.

THE APPLE-TWIG BORER—*Amphicerus bicaudatus* (Say).

This insect (Rep. 4, p. 51) has at last been found on the Atlantic sea-board, as I have received it from Mrs. Mary Treat, of Vineland, N. J., who found it boring into pear twigs. It has also been found in pear trees, received from Patapsco, Md., * but without any evidence that it came from that place. Regarding its larval habit, Dr. Henry Shimer has just informed me (March 24th) that he recently found a brief note of the breeding of this insect from grape-canes, the note being attached to the insect bred. This substantiates the statement in Packard's *Guide*, giving at least one known food-plant for the larva, and proving the great similarity between it and that of the Red-shouldered Sinoxylon, (*Sinoxylon basillare*, Say). The perfect beetles, received in the spring of 1872, have been kept alive for over five months, feeding on grape-vine, in a small phial.†

* *Country Gentleman*, June 13th, 1872.

† *Rural New Yorker*, Oct. 12th, 1872.

EGG OF THE HORNED PASSALUS — *Passalus cornutus* Fabr.

In my last year's account of this fine beetle occurs the sentence, "As larvæ only half-grown are found in company with those that are full-grown, they require at least two years to mature." This conclusion, though a very natural one, is entirely opposed to the facts. I have been surprised at the rapid development of the species which I have been able to breed from the egg. The eggs, which are deposited under the loose bark of decaying logs, are ovoid, with an average length of 0.12 inch, and diameter of 0.10 inch. The shell is smooth, flexile, but tough, and of various shades of olive-green, yellow, or brown. The newly hatched larva differs only from its full-grown self in having the legs relatively a little longer, the rudimentary pair mere fleshy tubercles, and in having four superior equi-distant, longitudinal rows of stiff rufous hairs as long as the diameter of the body, and each row one to a joint, except on the thoracic joints, where the lateral row is composed of several. The sides of the head and the ventral surface of the penultimate and terminal joints are also armed with such hairs. These hairs are very conspicuous, but in the mature larva they are either wanting entirely — being indicated only by the minute tubercle from which they sprang — or else are greatly reduced.

The eggs hatch all along through the month of July, and the larvæ acquire their growth and become pupæ in the amazingly short period of six weeks. It is for this reason that we find them of different sizes at one and the same time. The rudimentary legs are capable of a sudden and rapid side motion, which I have occasionally witnessed.

My stricture on Mr. Walsh's use of the term "decussated on the sternum," in describing the position of these rudimentary legs, was induced by a too restricted definition of the word, and is hardly warranted, according to Worcester.

EGG OF THE COMMON MAY BEETLE — *Lachnosterna quercina* (Knoch).

The eggs of this beetle, (Rep. 1, Fig. 88), which, so far as I am aware, have not been described, are white, translucent, spherical, with an average diameter of 0.09 inch. They are deposited between the roots of grass, and are inclosed in a ball of earth, evidently formed by the ovipositor of the female before deposition, as the cavity is sufficiently large for the egg to roll about in.

EGG OF THE BROAD-NECKED PRIONUS—*Prionus laticollis* Drury.

The eggs of this species (Rep. 2, Fig. 61) are elongate-oval, 0.15 inch long, and three times as long as wide. They are bright yellow, opaque, faintly granulated, (or rather impressed with abbreviated striæ), and fastened by a glutinous substance to stumps and old trees, about half an inch below the surface of the ground. The process of oviposition has been well described, (*Rural New Yorker*, July 20th, 1871), and I have obtained upward of 140 eggs from a single female in one night. The eggs of the other species of the genus are doubtless similar.

EGGS OF AMERICAN TENT-CATERPILLAR—*Clisiocampa Americana* Harr.

[Fig. 29.]

The figure of the egg-belt of this moth, which I have already given, (3d Rep. Fig. 50, *c*), is incorrect, in that it indicates the eggs to be bare, whereas, as described in the text, they are thickly covered with a glue-like varnish, which almost conceals them. That figure was not made from nature, and I was misled, at the time, by an incorrect figure given by Emmons in his "Insects of New York." The annexed figure (29) will give a far more correct view of the unhatched mass. There is some variation in the amount of glutinous matter covering the eggs, which are, at times, quite visible, at others not; and this difference may be connected with the difference of climate.

COUNTERWORKING THE TOBACCO WORM.

Mr. E. M. White, of West Fork, Reynolds county, sends me the following account of his method of counterworking the Tobacco or Potato worms, (1st Rep. p. 95):

"In every tenth hill on the outside rows of my field, I sow the seed of Jamestown Weed, (*Datura stramonium*), instead of setting tobacco plants. As the Daturas grow up, I pull out all but two to each hill, and when these are in bloom, I go around every evening, and, after destroying all but two flowers, pour into these a few drops

of common fly poison, mixed with sweetened water and whisky, [the fly stone of druggists is intended, it being an ore containing cobalt and arsenic]. The moths sip the poison, and die from it, and I find them scattered over the farm for a space of several hundred yards."

Mr. White's testimony corroborates that of many others who have killed these large Sphinx moths in the same manner.

THE GRAPE PHYLLOXERA.*

I have little in the natural history of this insect to add to the account given in last year's Report; nor have I found any occasion to alter the views then and there given. A few remarks, however, embodying the observations and discoveries of the year, on such an important insect, will naturally be expected. The reader can get some idea of the interest attaching to this insect when I state that in a bibliographical review† lately published by my friends Planchon and Lichtenstein, notices and summaries are given of 484 articles or treatises published during the four years of 1868–71.

MORTALITY OF VINES LAST SPRING.

There was very general complaint last spring of vine mortality, and this not from one but from many sections of our vine-growing country. This unusual mortality has been attributed to a variety of causes; and, after citing the views of a few grape-growers and horticulturists whose eminence and reputation entitle them to respect, and whose experience adds weight to their opinions, I shall endeavor to show how the Phylloxera, though generally left entirely out of the calculation, had much to do with the singular death of vines in the spring of 1872. In quoting these opinions, and to save time and aid precision, I shall italicize and number such passages as I wish more particularly to call attention to afterward.

First, we have the editorial opinion of the *Rural World*, as given in the following quotations from the number of that journal for June 1st, 1872:

---

*This word, though it really means "withered-leaf," has already become so well known and popular that it is as significant to the vine-grower as are the words "root-louse" and "gall-louse;" and has the advantage of tersely expressing and comprehending both these compound terms. It is also being used to designate the disease caused by *Phylloxera vastatrix* Planchon, (the scientific name *vastatrix* is universally being employed, and Fitch's *vitifoliæ* will have to give way,) just as the generic term Oidium is popularly used to designate the mildew caused by *Oidium Tuckeri*. The term *Phylloxera* will, therefore, in future not only apply to the insect, but to its effect on the Vine.

† *Le Phylloxera; Faits acquis et Revue Bibliographique, par* J. E. Planchon *et* J. Lichtenstein. Montpellier, 1872.

Mortality among Vines.—We have had our attention called to the great mortality among grapevines in some places, especially in St. Louis and Franklin counties.

There are two distinct stages of disease, or degrees of injury, visible among the vines. (1) First, *whole streaks or stretches in the vineyard are killed dead, and now dried out. The form of the portion is often quite irregular;* but we have, in every case, seen that there are certain analogies existing between the forms and two special facts that are subsequently stated. Second, there are very large and irregular pieces of vineyards in which the shoots are pushing very slowly, and in many cases are not more than three to six inches long, while the other portions of the vineyard have shoots over fifteen inches in length.

Among those who have lost heavily are our old, intelligent friends and neighbors, F. Braches, C. Paffrath and A. Stricker, while there are scores of others whose vines are in the second stage named.

Insects in general are claimed by some; others specify the root-louse as the cause. (2) *There is no special or direct evidence of the root-louse being at work at all. Neither the naked eye nor the magnifying glass can detect their existence on roots of the vines.* In the position of the vines they are liable to be affected by the drouth; the energies of the vines have been too severely taxed in the attempt to perfect the crop of fruit. As one or both of these influences were at work, the effect has been a reduction of vital energy, or the entire death of the vines.

In every instance of which we are advised, heavy cropping has been very clearly indicated. Some of the vineyards were exhibited last fall with a distinct reference to their abundant crop and liberal display of new growth; but, as the case now stands, we invite the attention of grape-growers, and solicit the full facts and opinions bearing on the subject.

That well-known and experienced grape-grower, Hon. F. Muench, sums up his views as follows, in the same journal for August 3d, 1872:

Grape Mortality.—During the first months of the summer, the vintner has to attend to his cherished vines with so much solicitude and care that he can hardly afford to engage in anything else. July will bring some relaxation, and thus I will once more take up the pen, instead of the knife and hoe, and make some remarks on the state of our vinicultural efforts.

I find the appearances of "mortality among the vines" correctly stated in No. 22, present volume of this paper; the evil, however, extends far beyond the counties of St. Louis and Franklin, in our State; it may, indeed, be traced through all of the Western States, more or less. The effect is before our eyes, but about the cause the vine sages differ. Let me briefly say what observation and experience have suggested to me.

What in the vine is called the inner bark, or liber, is, I think, in all plants with stems enduring through the winter—such as forest and fruit trees, vines, bushes, etc.—denominated *cambium.* It consists of a green, marrow-like matter, between the outer bark and the woody part of the stem or branch; is chiefly formed in the latter part of the season, and designed as the material from which, in the following spring, the first leaves sprout and also the blossoms come forth. The more completely formed and the more richly stored up the cambium is, the more vigorous will be the first growth of the whole plant, or of its several branches in the next season, and also the greater the productiveness. Different reasons may operate singly or in combination to prevent the proper formation of the cambium, such as—

1. A very poor soil.
2. A superabundance of branches and limbs.
3. A decrepid or otherwise sickly state of the plant.
4. Injury to the roots or leaves.
5. Very early frosts, or a fall time too wet and cold.
6. Overbearing.
7. Such a dry autumn that the scorched ground affords no nutriment to the tender capillary rootlets.

From all that I can see, and as a general thing, the two last mentioned causes combined have effected the mischief.

Last year most of our vintners had allowed their vines to bear about one-third more than is proper to allow. Such greediness is generally punished by the inferior quality of the fruit, by incomplete maturity, and also by a stunted growth of the vines in the following season—that is, by the want of the necessary new bearing wood. It was not so last year; already early in the season, sufficient new bearing wood, apparently sound and vigorous, had been formed, and the warm weather, uninterruptedly continued through September and the first half of October, not only matured our grapes, but developed in them such an amount of grape sugar as I have never witnessed

before. But therewith the whole natural power of the vines was fully exhausted; nothing, or too little, could be done for the shoots, the arid and impenetrable soil refusing to contribute any portion of alimentary substance.

What are the young shoots in the primary part of the season? A watery substance which afterward must be consolidated and furnished with the necessary ingredients; and just that was not done. I have examined such last year's shoots early in the spring, and found that their cambium amounted to nearly nothing. No wonder that such vines made either a scanty and sickly growth, or none at all.

(3) *The remarkable circumstance, that on the same piece of ground some of the vines are just as we could wish, and others either sickly or dead, may thus be accounted for: The one vine may have suffered by too heavy cropping, the other not; the one may have been naturally more vigorous, the other more feeble; here the subsoil may be more porous, there it may have been fully dried out and hardened, like a threshing floor; surely, neither the root-louse nor the winter frost had anything to do with this unexampled mortality.* The best thing that could be done, anyhow, was to cut back the vines to a few buds, near the ground, as soon as this morbid condition could be ascertained.

* * * * * * * * * * * * *

From an interesting article in the *Cleveland Herald*, by F. R. Elliott, in which the author gives an account of the exceptional death of many other deciduous and evergreen plants, and his belief that it was owing mainly to want of moisture, I abstract those passages which particularly refer to the Grape-vine:

It is this same want of moisture food to the roots that has caused more or less of Walter, Diana, Iona, as well as other late growing varieties of grapes—(4) *and especially of those having a large per centage of foreign blood in them*, such as Diana, Hamburg, Weehawken, Rebecca, Croton, etc.—to die out since the incoming of spring; for many of them now dead were, on the first of March, apparently perfect; as cuttings we now have, made at that time, show, and are growing, while the vines from which they were cut are dead. * * * * * * * *

Many vineyards of Catawba and Delaware are more than half destroyed, and even many vines of Concords. *Young vines, and those of strong growth and on sandy soils, have come out best.*

Dr. S. J. Parker, of Ithaca, N. Y., after showing (*Country Gentleman*, June 29, 1872) that nearly two-thirds of all kinds of grape-vines were partially or entirely killed, (5), *and that the Isabellas and Catawbas suffered most*, concludes with the following paragraphs:

Yet this much should be said. In vineyards trimmed early in the fall, and whose canes lay on the ground, the loss is hardly perceptible in a few instances. And it is not easy to explain why a vineyard like Mr. Baker's has his fine Rogers in beautiful estate, and his Isabellas, etc., also largely escaped, while others, with similar care and earlier attention, have suffered.

This is no trifling evil, and its causes and consequences need to be commented on. Let us first have the extent of this unusual damage and its peculiarities, and then, and not until then, *theory*, and the lessons to be learned by it. *That the remarkable dryness is connected with it I am certain; yet this can not be all.*

These extracts are from among many that might be given, but as they come from well-known writers, and include all the rational theories propounded, it is needless to quote further.

We see from the above that two principal causes are given to account for the result stated: 1st, Drouth; 2d, Overbearing. A third, namely, winter-killing, has been often urged; but meteorological data show that there was nothing unusually severe in the winter of 1871–2, at least in our section of the country, and the experience of Mr. E. A. Riehl, as given at the August (1872) meeting of the Alton (Ills.) Horticultural Society, proves pretty conclusively that winter-killing

should not be taken into account. In the fall, before cold weather set in, he cut 150,000 grape cuttings, which he put in a frost-proof cellar and preserved carefully; after putting them in sand they calloused and rooted well, but many had not enough vitality to push the eye, so that he did not make more than one-third of them live, though there was no chance of winter-killing, as the cellar was kept at an even temperature of about 55 deg. F.

That the excessive drouth had much to do with our grape-vine mortality, as it had with the mortality of evergreens and other plants, is quite evident. But that it was not the direct cause there would be serious reasons for believing, even were there no evidence of the fact in the above-quoted experience of others. The Grape-vine rather delights in dryness, and has been known to do well and yield abundantly under conditions of drouthiness which have killed evergreens and other trees. Moreover, this influence alone will not fully explain the irregular manner in which vines, under precisely similar conditions of soil and elevation, were affected; nor the greater mortality of some varieties than of others under such similar conditions.

Nor can the result be attributed to overbearing alone, for though cases of overbearing may have occurred, there is abundant evidence of vines dying where the yield, the year preceding, had not been larger than it is wont to be. Remembering also that in the spring of 1871 there was a late frost on the 17th of April, which cut off almost universally the first fruit in the more central portions of our own State, and that the crop consisted of the latent or secondary bunches, it is difficult to conceive how our grape-vines, speaking generally, can be said to have overborne, except where—already sick and injured from other causes—they were making that final effort at fruitfulness which so often precedes death; and where, consequently, such undue fruitfulness was the effect rather than the cause of disease. Mr. Horace Holton's vineyard at Webster Groves was so severely injured by the late frost of 1871 that it bore no fruit whatever that year; yet his vines suffered with the rest in 1872.

If then the undue mortality of grape-vines can not be solely attributed to either of these causes, what other influence would most nearly account for the facts in the case? I unhesitatingly answer *Phylloxera!* There is much that would go to prove this in the writings which I have quoted, as indicated by the italicized passages. We find that (1) the death has been noticed in streaks and stretches in the vineyard; that (3) in the same piece of ground some vines were sound and healthy, while others were either sickly or dead, and that (4) those varieties which most succumbed were those having a large per centage of foreign blood in them, or (5) else *Labruscas*, or, in short, just the very varieties which I have shown to be most injured by this insect. The fact (2) that there was no special or direct evidence of the root-louse "*being at work*," or that neither the naked eye

nor the magnifying glass could detect its existence on the roots, is precisely the state of things to expect whenever the lice have been injuriously or fatally abundant the previous year; and I can not too strongly or earnestly enforce the fact upon our grape-growers that by the time a vine dies, or is brought to death's door, by these root-lice, we can only discover the evidence of their work, as the lice themselves are no longer to be found.

But there is better proof than this circumstantial evidence, of the sorry part played by Phylloxera in the unwonted death of grape-vines last spring. That the lice were injuriously abundant on many kinds of vines, and in many parts of the State, in the fall of 1871, I know from personal experience, and have sufficiently shown; and in the spring following the more or less complete destruction of the roots, we might naturally have expected to find either lack of vitality or death of such vines. I also made a careful study of the mortality in the spring, digging up many dying or dead vines in the vicinity of St. Louis, and in every instance I found that the finer roots had wasted away, and that the larger ones were hypertrophized just as they are when injured by the root-lice; while upon those not yet dead there was no difficulty in finding the more living evidence of disease in the shape of the lice themselves, and the knots which they caused. In a vineyard belonging to Charles Paffrath, of Melrose, referred to in the extracts, I found a forcible illustration of the influence of Phylloxera. This vineyard is on a gentle slope, and is composed mostly of Catawbas, with which the owner has been quite successful, owing, as I believe, to the great pains which he takes to keep the roots healthy and vigorous, by first mellowing his soil to a great depth, and then planting with the utmost care. In this vineyard were both young and old vines, and the former had not suffered at all, while the latter showed greatest mortality, not in the higher or drier portion, but along certain middle rows, and mostly in the center. I examined the roots of many of these dead vines, as well as of some in the immediate vicinity of them, and was able to show the rotten and exhausted roots of the former, and the lice at work on the latter; and thus convince the owner, as well as Mr. Wm. Coleman, who was present at the time, that the lice, though unseen and unheeded, had not been unoccupied. No man could have been more skeptical as to the working of these lice than Mr. J. J. Kelly, of Webster; yet in a half day spent in his vineyard I was able to convince him that they had played an important part in the death of his Catawba vines. And so of others.

To summarize from the known facts in the case, I am of the decided opinion that, while the unprecedented drouth may be justly looked upon as the indirect cause of the trouble, the more immediate and direct cause must be attributed to Phylloxera. The meteorological conditions served to promote the undue increase of the lice at the same time that they rendered the vines less capable of resisting

depletion of sap. The conditions of a soldier in an army—where many are camped and barracked together, and where it is difficult to obtain hot water wherein to wash one's under-clothes—are favorable to the increase of certain body parasites, and other more invisible organisms, which produce disease. Yet, while in such a case the conditions have assisted, it is very palpable that the organisms are the direct cause of disease; and that if they can be warded off or removed, the disease may be prevented, though the conditions remain. Precisely in the same sense, I do not believe there would have been the mortality among our vines had the lice been kept off or removed from the roots.

It is a noteworthy fact that, notwithstanding the loss of vines, the general grape crop was large in 1872, and prices were so low as scarcely to be remunerative. It is very evident that the time is fast approaching, if it has not already come, when the simple growing of the Concord because it is hardy and bears neglect, will not pay; and in the future, only those viticulturists—basing their operations on more knowledge, more science—who can grow the finer-qualitied varieties, will find the business remunerative. One of the first requisites of success with these latter is, to my mind, a full understanding and management of the Phylloxera; and I am not without hope that those who do obtain this knowledge, and who put it into practice, will yet be masters of the situation, and succeed with the Wilder, the Goethe, the Catawba, the Walter, the Iona and other varieties of acknowledged excellence, but which are at present precarious.

I am aware that it is difficult to bring home to the average vintner any just sense of the importance of a microscopic atom, which is naturally hidden from his eyes, and which it requires some effort and training to see, and still greater effort to understand. There are few so simple as to deny the injury caused by the Chinch-bug, the Colorado Potato-beetle, and such other insects as, from their conspicuous size, render their presence and their ravages too patent; but where the enemy is so much more insidious, there will always be those who will deny its existence, or who, when made to see it by the aid of others, will prefer to look upon it as the effect rather than the cause of disease, and to attribute the disease itself to other causes. It is so much easier to deductively jump to hypothetical conclusions than to patiently and laboriously work out the truth by induction, and the proneness to attribute insect injuries to meteorological influences, and especially to drouth, is exemplified in the past history of many insect pests, and in that of the Hickory Bark-borer, given further on.

RANGE OF THE INSECT IN NORTH AMERICA.

I have found the galls abundant on wild vines of the species *Riparia* as far west as Manhattan, Kansas, and that it extends as far south as Florida, we learn from a communication from L. H. Tallman,

of Duval county, to the *New York Tribune* of September 4th, 1872, in which he speaks of the galls being abundant on what is known there as the Madeira or St. Augustine Grape, and upon the wild vines.

ITS SPREAD IN EUROPE.

In France, the Phylloxera has continued its ravages, and is spreading in Provence and Vaucluse, but not to the same extent in l'Herault. So threatening, indeed, has it become that the French Academy of Science has a standing Phylloxera committee, and M. d'Armand, at one of its sittings, demanded that the premium of 20,000 francs, offered by the government for a remedy, be increased to 500,000, or, if necessary, to 1,000,000 francs. The plague is also spreading in Portugal and Switzerland, and in some parts of Germany; while in England it is doing serious damage to hot-house grapes.

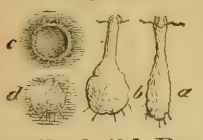
MORE FACTS ABOUT THE GALLS; THEIR TRANSIENT NATURE.

In the year 1870, and previously, the Clinton vine was always the most seriously affected by the leaf-galls; but an interesting change has since been manifested in the taste of the gall-making form (*gallæcola*) of our Phylloxera. In 1871, it became less numerous in this part of the country, and very generally abandoned the leaves of the Clinton and fell upon those of the Taylor; and what is still more singular, this same change was noticed in France in one case where these vines were cultivated in proximity. I have made many observations which prove this change to have been quite general, and shall cite a few instances in the foot-note* in corroboration. In 1872, I had such difficulty to find galls on either the Clinton, the Taylor or any other variety, in the early part of the season, that certain intended experiments and observations upon the Gall-louse were effectually frustrated. In some vineyards, later in the season, I found galls on Delaware, and a few, more or less perfectly formed, on Concord, and more especially on Herbemont. There seems to have been a persistent attempt on the part of the young lice to form their dwellings on the leaves of this last variety; but in almost every instance the attempt was fruitless, and the louse died soon after the gall commenced forming. On these vines, where the galls were suddenly arrested in

*Mr. T. W. Guy, of Sulphur Springs, had Clintons covered with galls in 1870, which, in 1871, were entirely free from them. Mr. Chas. Peabody, of Glenwood, also had Clintons covered in 1870, while in 1871 there were no galls in his vineyard, except sparsely on the Delaware vines. Dr. H. Clagett, of Gray's Summit, had Clintons covered in 1870, fewer in 1871, and in 1872 could find none in his vineyard. Mr. J. Squires, of DeSoto, and Mr. N. DeWyl, of Jefferson City, report a similar experience. Mr. O. S. Westcott, of Chicago, Ills., informs me that a striking instance came under his observation of an abundance of galls on Clintons in Kendall county, in 1870, succeeded by an entire lack of them in 1871. Dr. LeBaron reports a similar experience. M. Laliman writes that at Bordeaux the Gall-louse, which had been abundant on Clinton in 1870, left that variety and went on to the Taylor in 1871.

various stages and degrees of completion, the method of formation was easy to observe. The first effect of the puncture is a slight depression of the upper surface, bordered by a circular fringe of down (Fig. 30, *c*); the under or convex portion being covered with fulvous down (Fig. 30, *d*). As the depression increases, the circular fringe closes up and forms the mouth of the gall, as already described (3d Rep., p. 87). I saw Herbemont vines whose leaves were covered with these abortive galls, and saw them, not only in Missouri, but in Kansas. On some of the wild vines in the last-named State, I have also collected galls which were so lengthened that they appeared quite abnormal, and almost pedunculated (Fig. 30, *a*, *b*).

[Fig. 30]



This inconstancy in the habits of the gall-lice furnishes another interesting instance of the changeableness of Nature, and of the difficulty the naturalist encounters in making generalizations. It is impossible, at the present time, to give the rationale of this change of habit, though future discoveries may explain the facts and render them significant.

SUSCEPTIBILITY OF VARIETIES.

The relative immunity of most of our American varieties, compared with the European, is exemplified in Europe as well as in this country. Several interesting instances are cited in *La Province* of Bordeaux (Nov. 26, 1872) of our vines being cultivated, for a number of years, in the midst of affected French varieties without injury; while M. Laliman has been more explicit, and, mentioning varieties, has shown that as with us the *Labruscas*, as a species, suffer most, (*Ann. de la Soc. d'Agr. du Dép. de la Gironde*, Vol. XXVI, p. 19).* M. J. Leenhardt-Pomier, of Montpellier, reports that the vines which he received from this country are doing well, and gives, in substance, the following details, under date of November 6, 1872: "Cunningham showed most vigor, the leaves being as green as in summer. Next, the Herbemont gave most satisfaction. Third, the Clinton. The Concord and Goethe ranked next. The Rentz, and especially N. Carolina, made but a feeble growth, while the Cynthiana and Ives' Seedling did not succeed at all."

From examination of some California vines, in Mr. G. Gill's vineyard at Kirkwood, I discovered that they were badly attacked by the

---

*M. Laliman has published (*Journ. de Viticulture Pratique*, April 25, 1872) a colored plate of what is known there as the York Madeira, or Bland Madeira, a vine which he considers is the very best as resisting the Phylloxera. The plate is beautiful, but it is difficult to establish from it what variety is meant. It is evidently a *Riparia*, having a smooth leaf, and black berry, and, according to Mr. Bush, it resembles the Aughwick in leaf and the Israella in bunch. Husmann finds that it resembles the Franklin. According to Downing, the Bland Madeira has a red berry, and the York and the Bland can not be synonymous. The plate represents a variety evidently not cultivated in our State.

Another variety, which is unnamed, and which is No. 1 of his plate, published in his work entitled "*Etude sur les divers Phylloxera,*" successfully resists the *Phylloxera*. The leaf might belong to Norton's or Cynthiana; but it is impossible to give accurate judgment from a single leaf-figure.

root-lice. It is thus rendered quite certain that, if it once finds its way to the Pacific slope, our Phylloxera may prove a most serious scourge, and it behooves the Californians to endeavor to prevent its introduction. Let them take warning of France!

AMERICAN GRAPE-VINES IN FRANCE.

The fact that some of our American varieties resist the louse has caused an increasing demand for them abroad. The principal varieties sent by Messrs. Bush & Son are the Cunningham, Herbemont, Taylor and Clinton, which have been found to resist with M. Laliman, as well as here; and the Norton's Cynthiana and Concord, which succeed well with us, but have suffered with M. Laliman.

As some of my foreign correspondents have thought it would be cheapest to order long cuttings, with several eyes, it will be well to state, for their benefit, that few of our American vines root as easily as the European varieties, and it is almost impossible to propagate some of them, except by layering. With the exception of Clinton and Taylor, those which propagate easiest by cuttings are, as a rule, the most sensitive to the Phylloxera, while those which are with difficulty so propagated are among the best resistants. This is very much what we should naturally expect: the tougher the wood the tougher the root, causing, in the one instance, difficult rooting, and in the other better resistance to the suction of the louse. The accompanying list, showing the comparative difficulty with which some of the better-known varieties root from cuttings, and which is based on the experience of Messrs. Bush & Son, will prove of value in this connection:

1. HERMANN (*Æstivalis*)—Most difficult of all to propagate; refusing to root even with bottom heat.
2. NORTON'S and CYNTHIANA (*Æst.*)—In a very favorable season, on well-prepared, virgin soil, and with the best care, only a small per centage will root.
3. HERBEMONT, CUNNINGHAM, DEVEREUX (*Æst.*)—From cuttings made *early* in fall, *soon* after the leaves drop, and under very favorable circumstances and conditions of soil, a better per centage than from the former will root; yet they often entirely fail.
4. RULANDER, LOUISIANA, ALVEY (*Æst.*), and DELAWARE (*Rip.*)—Are less uncertain than the former, and with skillful treatment, first causing callus, with best of care afterward, good results have been obtained at times. Without such treatment and care, these also will not root well from cuttings.
5. EUMELAN (*Æst.?*), CREVELING, MAXATAWNEY (*Lab.*)—Root more freely, and with proper care may safely be propagated from cuttings.
6. HARTFORD PROLIFIC, TELEGRAPH, IVES, CONCORD, CATAWBA, IONA, DIANA (*Lab.*)—Root easily from cuttings. Being mostly long-jointed, they make better roots and plants from short cuttings (2 to 3 eyes long) than from long canes.
7. ROGERS' HYBRIDS, as GOETHE, MASSASOIT, WILDER, LINDLEY, AGAWAM, MERRIMAC, SALEM, ETC.—All varieties produced by crosses between *Labrusca* and *Vinifera* grow from cuttings as easily, at least, as the varieties of either of these two species. ARNOLD'S HYBRIDS, crosses between Clinton and foreign (*Vinifera*) varieties, grow from cuttings even more freely than any others, except—
8. CLINTON and TAYLOR (*Rip.*), which grow from cuttings, like willows, almost without care.

So far as I can learn, the varieties of *Vulpina* root with difficulty from cuttings.

As an evidence that our grapes are beginning to be appreciated in Europe, I may be pardoned for quoting the following from one of M. Laliman's letters: "The wines which I obtain from certain American varieties age very rapidly, and I may tell you that the Jacquez, [I do not know this variety, unless it be a synonym of the Ohio], the Lenoir, the Clinton and the Long, [known to us as the Cunningham], mixed together, give me a wine much superior to those I get from our French varieties. The Delaware, also, mixed with the Taylor, makes a very agreeable wine."

In an article written by him last April,* he further says: "Certain vines of the *Cordifolio* [*Riparia*] species make a very good wine; and certain hybrids, as well as some varieties of *Æstivalis*, produce wines so like our own that we shall find it to our advantage to cultivate them, not only from an alcoholic stand-point, but for an abundance, color and taste, which will astonish those who are acquainted with the *Labrusca* only. * * * The Americans have made such rapid strides in horticulture of late that, we repeat, they have entirely changed the character of their vineyards. Certain grape-growers have succeeded, by hybridization, in so improving their wild vines that their grapes to-day equal our best products of the kind."

This speaks well for American vines, which our fastidious transatlantic friends deemed, not long since, unfit for cultivated tastes. But whether these vines be there appreciated for their fruit or not, they will prove valuable as graft-stocks. Mr. DeWyl has the Goethe, Salem and Rogers No. 12 grafted (under ground) on to Taylor roots, and, although a few galls are found upon the leaves, the grafts are doing well. By growing such Hungarian vines as Tokay, Foment and Scegety on Concord roots, and protecting them in winter, he has also succeeded in making them thrive and bear. Indeed, the benefits of grafting the more susceptible varieties on to the roots of those which best resist the Phylloxera, must be patent to all; and in thus grafting we have one of the few practical methods, so far known, of thwarting the enemy.

It is to be regretted that more caution is not taken by those who write upon the subject of the Phylloxera. In the monthly report from the Department of Agriculture for February, 1872, it is stated that varieties of *Labrusca* are freest from attacks of the louse; whereas *Labrusca*, as a species, suffers most. Such careless statements mislead, and may account for the fact that the varieties imported by the French minister have been mostly of this species. Some few of the *Labruscas* effectually resist the louse here, and there is every

---

* *Réponse à la Soc. Linnéenne.*

reason to suppose they would do so there; but, until further experience shall give more decided results, we must be guided by that of M. Laliman, across the ocean, and our own here, as given last year (Rep. 4, p. 64).

With regard to the best method of grafting the grape-vine, it may be well to state that such grafting requires the greatest care, and that experienced authors agree that it is best done under ground, and soon after the frost is out in spring. Details will be found in the standard works on grape-culture; and I would refer to articles in the last volumes of the *Western Planter* and of the *Rural World*, and more particularly to the number of the last-named for February 1, 1873.

NEW THEORIES.

Quite naturally, there have been numerous persons abroad ready to assert that the Phylloxera was the effect rather than the cause of disease. Such opinions, from some quarters, would not cause surprise; but when intelligent naturalists like Messrs. Signoret and Guérin-Méneville persist in such belief, it is difficult to give any other explanation than that they are too much absorbed in closet studies to make the proper field observations; or are biased in favor of theories hastily announced before any field studies were made. In the face of the gradual spread of the disease from infested to uninfested regions, and of the exemption which vineyards enjoy where the insect has not yet appeared—in face of the demonstrable and hurtful results which follow its puncture, and the isolated spots or centers of attack from which it often originates—men still have the hardihood to compare the disease with scrofula in man, to attribute it to "meteorological perturbations," and other equally illusive explanations. They invoke some remote, mysterious cause, and prefer the vague to the definite. Most of them would, of course, scout the idea of these mysterious causes producing the lice, for they would scarcely go so far, even if abiogenetically inclined; but I can not help likening their views to those of the average Cockney, who so implicitly believes that the east wind and certain atmospheric conditions peculiar to London, beget and engender the myriad lice which blight his plants at certain seasons. For my part, I want no better explanation than the greater tenderness and susceptibility of the European vines compared with those on which the lice have bred from time immemorial in this country.

In spite of the abundant rains that have, from all accounts, soaked the vineyards in the infested districts of France without decreasing the disease—in spite of the fact that other plants have not suffered for want of rain—the sophism is still reiterated that the disease is owing to meteorological abnormities, and especially to drouth. The poor wine-grower is told to wait for more rain, and that if he pursues

that treatment which will cause the vine to regain its normal vigor, he will see no more of Phylloxera — a most undoubted truism! I am the last to deny that meteorological conditions accelerate or retard the multiplication of plant-lice, as they do of so many other insects; but I see no reason for presupposing a diseased condition of the plant first attacked by them, when, as every entomologist knows, they can flourish only on living vegetation, which they forsake when its life has been sapped. Conditions may be favorable to the increase of the plant-lice on our hops, of Cotton-worms, of the Army-worm, and of a thousand well-known insect pests; yet no one doubts that if by increased effort we, in some way or other, prevent or destroy these insects, we effectually overcome the (to us) unfavorable conditions, and our plants thrive.

Whenever abundant enough to attract attention, these plant-lice have already brought the infested plants into a state of disease, and it is this fact which blinds so many persons, and makes them so ready to believe that it was the diseased condition which attracted, or, as some more ignorantly put it, "produced," the lice. *Aphidæ*, I repeat, (Rep. 3, p. 87), must always be the cause rather than the effect of disease.

I shall simply add in this connection, as strengthening the position of those who consider Phylloxera the true cause of the mischief, that I never yet found root-lice so abundant as on some California vines belonging to Mr. G. Gill, and which were unusually well cared for and manured.

Other persons, again, have, as might have been expected, insisted that the European insect is not an importation from America, and argued that it may either be a distinct species, either indigenous to both continents, or else may even have been imported from Europe to America. To waive unnecessary detail, I may state that such views are based on fallacious grounds, and that, setting aside theory, and weighing the undeniable facts, the evidence gives overwhelming force to the opposite view — that the insect is a native American, and was originally unknown in Europe;* and indeed the views expressed in my last report were adopted by M. Plumeau and others, at the recent organization of the French Society for the Advancement of Science, when the Phylloxera occupied much attention.

* M. L. Laliman, of Bordeaux, is, perhaps, the most voluminous and influential writer who has espoused the last-mentioned doctrines, in opposition to Lichtenstein, Planchon, myself and others (*Annales de la Soc. d'Agr. du Dep. de la Gironde; Jour. de Viticulture Pratique; La Gironde; La Provence, etc.*). Assuming that the insect has always existed in both hemispheres, he quotes M. E. Nourrigat, the President of the *Comice* of Lunel, as proving that it played havoc in Germany from 1730 to 1776. There is no proof whatever that the disease which attacked vines in Germany during that epoch, and which likewise affected the Mulberry and other fruit trees, bears any relation to the Phylloxera disease in question. The article of M. Nourrigat, referred to, first appeared in the *Journal de Lunel*, of March 28th, 1871, and describes a disease which, first noticed in Austria, along the Danube, desolated Moravia, Hungary and Germany, and finally penetrated into Alsace; but from the symptoms given, it has plainly no connection whatever with Phylloxera. M. Laliman, to support his views, ventures a theory so visionary and untenable as to presuppose the existence, from time immemorial, of the Phylloxera on trees and plants, whose disappearance and eradication have caused it, as he believes, to attack the Vine. I presume he was led to such theories by the fact that a certain root-

MEANS OF CONTAGION FROM ONE VINE TO ANOTHER.

The modes of spreading indicated last year have been fully proved correct. There can be no doubt about the young lice traveling under-ground along the roots of the vines, or in any cracks or minute passages in the soil; while I had no difficulty last August in finding them crawling over the surface of the ground. Moreover, M. Faucon and M. Gaston Bazille discovered not only the larvæ, but the winged individuals, passing abundantly over the surface of the earth last September, in France, and we thus have evidence that the winged insects make good use of their legs. They have likewise been caught in spiders' webs, and seen in other situations to which they must have

---

louse was found on wheat in several parts of France the past year, and that other root-lice, supposed to be Phylloxera, were found by himself and others on the roots of several fruit trees. So there is a well-known root-louse, producing knots on Apple, and others, either little known or undescribed, on Purslane, Turnip, Persimmon, and many other plants in this country; but they are distinct species, and the entomologist will want other proof than is yet forthcoming ere he can believe that *Phylloxera vastatrix* attacks anything else but the Vine. But M. Laliman goes still further, and weakens all faith in his deductions, by promulgating the abstract ideas that the soil is impregnated with plant-lice, and that the increase of Phylloxera is in some way due to the destruction of birds. In support of the view that the European insect is a distinct species, and was not introduced on American vines, he makes three statements: 1st. He publishes the annexed letter from Mr. Berkman, of Georgia, of whom he obtained his American varieties, to prove that Phylloxera is unknown there:

"In our region, the Phylloxera is unknown. Riley observed it in 1864 in Missouri; at that time it was injurious to the Clinton; but in fact the plague which ravages our vines is known only to entomologists through scientific investigations; vintners do not dream of its presence, and the damage it does is not worth speaking of."

2d. That American vines are not affected exactly alike here and in France, so far as his and my experience go. 3d. That he has distributed American varieties through divers countries where the malady is unknown, without introducing it.

None of these statements prove his position. 1st. If the insect is unknown in Mr. Berkman's section, (the State of Georgia is pretty large, but no postoffice address is given), it only indicates that it was not sent over on his vines, but does not prove that it was not sent from other sections, either to France direct, or via England; while Mr. B.'s mere dixit that Phylloxera is unknown in his region, without attending proof, will have little weight when we reflect that three years ago no one dreamt of the existence of the root-louse in any part of this country. We have, moreover, seen that it *does* occur as far south as Florida. 2d. The sort of argument that proves the insects of the two continents distinct, because the vines in the two hemispheres are not affected alike, would equally prove that the *Oidium* which so troubles grape-vines in Europe is not the same as ours; for there is good evidence that some of our vines are sorely troubled with it here; whereas, he himself shows that his American varieties are not affected by it there. Yet I know of no mycologist who has studied the subject who doubts the identity of the *Oidium Tuckeri* Berk. of Europe and America. I have seen what was evidently the same, prevalent in the vineyards of Michigan; but not to rest on my own authority, I may say that Mr. Husmann believes the two identical, and I shall append to this note the testimony of Mr. William Saunders, of Washington.

In considering the relative susceptibility of the same varieties in the two countries, defective, imperfect experience and climatic and terrene influences are important factors which have been overlooked by M. Laliman. 3d. The statement that he has sent American varieties to different countries where the malady is unknown without introducing it, would have more force if he had stipulated the varieties sent, and whether, when sent, he observed that their roots were lousy or not.

Finally, the same author refers to my writings in a controversial spirit, and makes the same pardonable mistake as have other writers, (see Dr. Le Baron, *Prairie Farmer*, September 21, 1872; A. H. Trimoulet, *Mem. sur la Maladie Nouv. de la Vigne, Bordeaux*, 1873, and others), of considering the earlier conclusions, drawn from imperfect knowledge of the insect in America, without taking into account the subsequent and more mature convictions of greater experience. He wonders how I could recommend the destruction of the Clinton one year, and reverse the recommendation the year following; when a closer reading of my last year's article would very plainly give him the reason. As to his criticisms of the classification adopted, I attach more importance to recognized American botanical authority than to the opinions of one who even confounds the terms species and genus. M. Laliman also publishes the contents of a letter of inquiry addressed to me, under date of December 14, 1871

flown; and there is no longer any doubt—as there had never existed any in the minds of entomologists—about their flying capacity. On a calm, clear day, the latter part of last June, it was my fortune to witness a closely allied species (*Phylloxera caryæfoliæ*) of the same size and proportions, swarming on the wing to such an extent that to look against the sun revealed them as a myriad silver specula. They settled on my clothing by dozens, and any substance in the vicinity

---

but either because my answer did not reach him in time, or because it explained away his antecedent objections, and would necessitate their expunging, my answer to said letter does not appear.

It is an unprofitable business to have to meet theories and objections which have in themselves little force; but, lest silence should be construed into acquiescence in M. Laliman's views, I have deemed these few remarks proper, though somewhat irrelevant and of import to but few. While thus reprehending M. Laliman, I heartily concur in his advice to import from America vines which have best resisted the *Phylloxera*, and in the caution urged upon those who would import all the *Labruscas*.

PROOF OF THE OCCURRENCE IN AMERICA OF OIDIUM TUCKERI, OF EUROPE.

Communicated by Mr. Wm. Saunders, of the Department of Agriculture.

It is now twenty years since I became convinced of the presence of *Oidium Tuckeri* in this country. Previous to that time I had been giving what attention I could to the study of mildew—its origin, causes, etc. I early became convinced that there were two very distinct forms appearing on the grape-vine, and moreover, that one of these forms was most prevalent in dry weather, and the other in damp weather. It had been ascertained that the foreign grape, even when grown under glass in this climate, was very liable to attacks of mildew; and in all book directions, at that time, as to its culture, sulphur applications were constantly recommended. From its close resemblance to the pea *Erysiphe* of Europe, that I had often seen in England, attacking peas in dry summers, (and only during periods of great drouth,) I concluded this mildew, appearing like a white down, or floury mass, on the *upper* surface of the leaves of grapes in the glass grapery, and occasionally spreading itself over the young green shoots and berries, was an *Erysiphe;* I named this in my first published notices (see *Phil. Florist*, 1852, and *Horticulturist*, 1855,) as an *Erysiphe*. I reached this conclusion from other points—notably, the English gooseberry, Persian Lilacs, English hawthorns, oaks, etc. These, when grown in this warm and arid climate, become covered with this same, or a very closely allied form of *Erysiphe*. Before promulgating this opinion, I had, as has always been and still is my practice, to first verify to my own satisfaction the truth of my statements. Acting upon the theory that this form of mildew was produced on the foreign grape in graperies, as well as oftentimes in the open air, by dryness, I commenced and have since recommended a mode of treatment, which is now generally followed, and which entirely obviates any necessity for sulphur applications, because it prevents the occurrence of the conditions necessary for the growth of this fungus. The treatment is, briefly, to ventilate graperies only from the top of the house, never opening any side sashes that will allow a current of dry air to come from the exterior and circulate out at top, carrying with it the moisture of the house; also to maintain a moist atmosphere by keeping the floor of the house constantly damp, and sprinkling water freely on very bright days, so that as the temperature increases the atmospheric moisture will also be proportionately increased. When this practice is fairly carried out, no mildew of an *Erysiphe* kind will make its appearance. I did not then, so far as I now can recollect, connect this mildew with the *Oidium* of Europe, until later, when it was discovered that the so-called *Oidium Tuckeri* was simply a form of *Erysiphe*, or rather a transformation occurring during its growth. (I think that this *Oidium* or *Erysiphe* has not yet fruited in England.) This led me to further investigations, and proved to me that our *Erysiphe* was really and truly the *Oidium Tuckeri* of England, and moreover, that the plant perfected itself fully in this climate. This was my conviction fifteen years ago; recent microscopical investigations prove beyond doubt the correctness of my suppositions.

But we very rarely observe this *Erysiphe* on our native grapes in ordinary vineyard culture, although it is frequently to be found on vines growing in warm, very sunny, sheltered, dry positions, such as may always be found in city yards. It is not by any means confined to these, however. Last summer we had plenty of it on the leaves of many varieties growing on our trellis here. As already remarked, this mildew shows a powdery appearance on the *upper* surface of leaves, and frequently forms a somewhat leathery coating on shoots and berries. Its effects are to corrode and prevent the further swelling of the parts attacked. Grapes, for instance, that are touched by it, will show an indurated spot, hard and brown, the portions of the berry not attacked will swell out freely, and all that this hurt portion can do is to crack open, which it usually does, and the seeds may frequently be seen to protrude from this crack.

But the mildew most injurious to our native grapes is altogether different. This is a *Peronospora*, and shows itself on the *under* surface of the leaves, usually looking like a small patch of whitish-brown downy matter. It adheres closely to the leaf, and is a perfect parasite; it destroys the part where it adheres, the sun burns a hole, and it is called blister, leaf-blight, etc. But if you say that it is mildew—oh, no! I never had any mildew. I have lots of amusing incidents of this kind in my mind: Some whose vines were all but denuded of foliage would still insist that they never had a case of mildew, until I convinced them of the facts, and pointed out the mildew to their wondering eyes. Being confined to the under surface of the leaves, it escapes observation. This mildew is encouraged by dampness on the foliage, by continued damp, rainy weather, or even constant heavy dews, followed by still, balmy days; anything in fact that will prevent moisture from quickly leaving the foliage.

About 1857, I tried a board covering over a trellis of Catawbas that yearly failed to mature their fruit, owing to the destruction of the foliage during summer by this mildew, and the effect was all that could be desired. In the Agricultural Report for 1861 you will find this affair figured. This covering prevents the radiation of heat from the plants, consequently they are not rendered so cold as to condense upon them the moisture of the air and form dew. A series of observations made many years ago with registering thermometers explained to me the *modus operandi* of the whole. During still, clear nights in July, I found that the thermometer, having clear two feet from the trellis, would fall from five to ten degrees lower than the thermometer directly under the cover.

that was the least sticky was covered with them. With such a sight before one's eyes, and with full knowledge of the prolificacy of these lice, it required no effort to understand the fearful rapidity at which the Phylloxera disease has spread in France, or the epidemic nature it has assumed. Imagine such swarms, mostly composed of egg-bearing females, slowly drifting, or more rapidly blown, from vineyard to vineyard: imagine them settling upon the vines and depositing their eggs, which give birth to fecund females, whose progeny in five generations, and probably in a single season, may be numbered by billions—and you have a plague (should there be no conditions to prevent that increase) which, though almost invisible and easily unnoticed, may become as blasting as the plagues of Egypt!

THE MALE LOUSE.

M. Signoret, because he has not seen the male himself, has seen fit, both in print and by letter to me, to deny that it has yet been seen by any one. It may please my friend to be thus incredulous, but I have certainly noticed the differences specified on page 59 of my last Report, both in specimens obtained from France and those obtained in this country. Both Lichtenstein and Planchon likewise believe that they have seen the male, and pointed out the differences before I was familiar with them myself. We know positively that his presence is not absolutely necessary, and that the females greatly preponderate. A knowledge of his appearance, therefore, is of little practical moment; but as it is of considerable scientific interest, I regret that I did not know of M. Signoret's skepticism in time to have dispelled it the past year. Being absent from home during the months of September and October, I saved no winged specimens in 1872; and on looking at those saved in 1871, I found that the acetic acid in which they were preserved had so destroyed them that little but a white soft mass of matter was left. From a few preserved in glycerine I found one specimen of what I have taken for the male; and, though discolored, it has been forwarded to M. Signoret at his request—with what results I have not yet learned. *Nous verrons!*

REMEDIES.

The new insecticides that have been tried, and the various measures that have been essayed to destroy the Phylloxera, are innumerable, and the French horticultural and agricultural journals teem with them. Practically, however, the great mass of them are useless. Next to carbolic acid, soot has been found most efficacious, and a mixture of these two articles may be profitably employed to save a few choice vines which are known to be suffering from Phylloxera, and where they may be applied thoroughly. In this country, where the disease is not likely to become threatening on our tougher rooted, native varieties, these applications will never be made extensively;

but a remedy—even if laborious and expensive—will be of great use to us in saving the finer varieties; and, judging by the experience in Europe, I greatly incline to believe that these finer varieties, and even the European vines, will succeed on our bluffs, if planted in trenches first prepared with a mixture of sand and soot, or the carbolic powder presently to be mentioned.

The value of submersion or irrigation, where it can be effected, has been demonstrated by M. Louis Faucon,* of Graveson, (Bouches du Rhone), France, who has been indefatigable in his experiments, and who considers that he has totally annihilated the insect in his own vineyard. From his experience we may draw the following conclusions: 1. A vineyard should never be submerged more than two days consecutively during summer. 2. The best season to submerge is in autumn (September and October) when the lice are yet active and the vines have ceased growing. 3. Brief and repeated inundations have little effect on the lice: a submergence of 25 to 30 days is required to rout them all. 4. He finds that a submergence for such a period in the fall or winter does not injure the vineyard, and kills all the lice. 5. He makes an embankment around his vineyard, and lets the water evaporate, but does not let it run off and carry away any nutritive properties of the soil.

On our best hilly vine land submersion is impossible; but on some of our bottom lands, the Catawba, which is always in such demand for the manufacture of sparkling wine, may be made to flourish by this means.

The fact, now ascertained beyond peradventure, that the insects, both winged and wingless, crawl over the surface of the ground in the months of August and September, has led to the idea of sprinkling the surface with quick-lime, ashes, sulphur, salt or other substance destructive to insect life, during those months. This is a practical step toward the ultimate management of the insect, and adds still more importance to submergence and inundation.

M. Lichtenstein has been experimenting in the way of alluring the lice on to the tender rootlets of newly-set cuttings and layers, and finds that a great many lice may thus be destroyed. He advises, whenever a center of attack has been discovered, to layer the yet healthy vines surrounding the already dead and dying ones. These

*M. Faucon (*Messager Agricole du Midi*, February, 1872) appeals to me for information as to the conditions of planting, nature of soil and climate, which obtain with us, and the kind of vines, whether wild or cultivated, upon which my observations were made. Most of the questions which he puts to me have already been answered; and I may add briefly, that our Missouri soil, comprising most of the vine lands, is either a sandy loam, or a heavier yellow clay, both with a limestone subsoil, and often with a layer of pure sand intervening. The heavier clays are stronger, and give a heavier must, but vines are generally healthier on the sandy loams. These soils are not subject to periodic inundations, and to the best of my recollection they are not unlike those around Montpellier. Our vines are usually cultivated on trellis, eight feet apart in the row, and six feet between rows. The climate is much like that of the South of France, though more extreme and changeable. We sometimes have milder winters, but ordinarily the frost penetrates deeper. We are more subject to drouth than to excessive rain, but we have no greater drouths than have occurred in South France of late years.

form a sort of invitation barrier to the lice, which are continually spreading from the dying vines, and great numbers settle on to the layer rootlets, and may easily be detached from the main stocks and destroyed. This can never be more than a partial barrier; but every practicable and intelligent means of combating such an enemy helps. By splitting the ends of the layers or cuttings, they produce a great number of minute fibres, which are especially attractive to the lice.

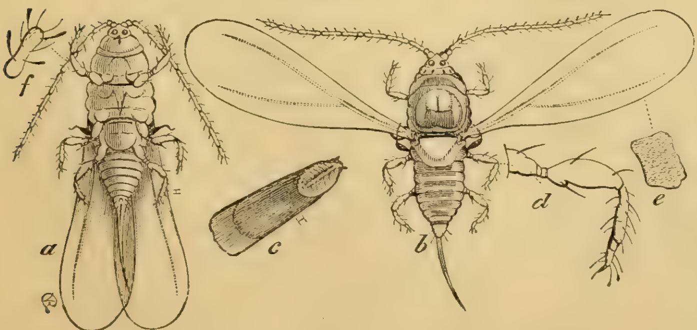
My own experiments have been solely with carbolic acid, and the results can only be fully ascertained the forthcoming season. It is perfectly impracticable to use the liquid solution on our hills and bluffs, upon which water can be carried only at great cost and effort; and, at my suggestion, G. Mallinckrodt & Co., of St. Louis, have prepared a cheap powder, which, in quantities in barrels or casks, they sell for 5 cents per pound. I found this quite convenient, and have treated a number of vines with it, in varied quantities, at Kirkwood and Bushburg.

The following letter, received March 7th, 1873, from Mr. F. A. Brewer, of Chillicothe, bears on this subject and is suggestive:

"Having been interested in your writings on Phylloxera, and not understanding the bad condition of my Catawbas, I examined them in the spring of 1872, and found the excrescences on the roots and deadened portions, as you describe. This left no doubt in my mind that the lice had been at work. So I opened the ground, exposing a goodly portion of the roots, and thickly sprinkled leached ashes and a little sulphur over the parts exposed, and replaced the dirt. I cut away all dead wood, and the sprouts from the trunk look well, and I think will produce me a fair crop this year. Will report to you this fall again."

THE OYSTER-SHELL BARK-LOUSE OF THE APPLE—*Mytilaspis pomicorticis* N. Sp.

[Fig. 31.]



Since the publication of the article on this insect in my first Report, several interesting and important facts in its economy have been revealed, and I am now able to give a much clearer insight into the life-his-

tory of the little animal which causes what is often called "scurvy" on apple-trees.

ITS OCCURRENCE IN MISSOURI.

From numerous facts stated, and from experiments made, in 1868, I had every reason to suppose that this insect could not thrive at any point south of St. Louis, and that it had, up to that time, not yet been introduced into the State. But, alas! both these cherished notions have been dispelled like "the baseless fabric" of a vision, and I am very forcibly reminded of the uncertainty of analogic reasoning, and how necessarily imperfect and partial human knowledge must always be! The conclusions drawn from the facts at hand in 1868 were: 1st, that this Oyster-shell Bark-louse did not yet occur in the northern part of the State, though quite capable of existing there; 2nd, that by care and caution on the part of orchardists in the more northern counties, its introduction could very easily be prevented; 3rd, that it could not thrive in the southern half of the State. The first conclusion, from all I have been able to learn since, was fully warranted; for, except in the latitudinally opposite localities presently to be specified, I have not met with or heard of it. So truly indeed is this the case that specimens for study were necessarily obtained from these localities, or from the more northern parts of Illinois, and the observations here recorded were, consequently, made under difficulties. The soundness of the second conclusion we have been abundantly able to test, for the worst fears that the pest might be introduced have been realized. Just as might have been expected, also, it has gained a footing in the extreme northeast corner of the State—the point of greatest proximity to the infested sections of Illinois and Iowa.

In the spring of 1870, Mr. B. P. Hanan, of Luray, Clark county, sent me some Sweet June apple-twigs that were completely covered with the scales of this Bark-louse, and the eggs underneath the scales were plump and healthy. The twigs were taken from the orchard of Dr. Wm. H. Martin, of Kahoka in that county, and I quote part of Mr. Hanan's letter which accompanied them:

> "This tree is rather badly infested, and I find by examination that they (the insects) are spreading slightly on to the nearest trees around it. Will they spread from one orchard to another, one or two miles distant? I saved my orchard from the native White Bark-louse by sending you specimens of them and of their foes, and by learning from you what to do to destroy the lice. I took your advice, encouraged the ladybirds, and they cleared my trees of the lice. If your advice in this case shall accomplish as much for my friend Dr. Martin, the object of this communication will have been accomplished."

At my suggestion, the tree was cut down, and other measures taken to eradicate the evil on trees adjoining; and, from correspondence, I was finally led to believe that it had actually been eradicated.

But toward the close of 1872, just before giving this report to the printers, I concluded to write again to Mr. Hanan, and learn the latest experiences. The following is his reply:

Dear Sir—In reply to your inquiries of the 27th, in regard to the Oyster-shell Bark-lice on Dr. Wm. H. Martin's apple trees, in Kahoka, in this county, I will state that I have just returned from a visit to his and his neighbors' orchards.

I long ago satisfied myself that the Dr. had them all exterminated from his trees, from what he had told me at various times. And as I could neither find nor hear of them being on the trees in any other place in our county or State, I gave the matter but little thought of late. But imagine my surprise and sorrow when, to-day, I found them more abundant on Dr. Martin's trees than when I first wrote to you about them, in February, 1870. In your reply to that letter, you requested Dr. Martin and his neighbors to use every possible effort to destroy them and prevent their further spread, as they were the only ones known to be in our State; and you referred us to your article on the insect, published in your report of 1868. Dr. Martin, in the early spring of 1870, cut down the Sweet June apple tree, which seemed at that time to be the only tree much infested, and carried it into an open space, forty or fifty yards from his orchard, and burned it up, after leaving it lay there for several days. He cut it down about four feet from the ground, at the first branches, then scraped the trunk or stump well, and destroyed the eggs scraped off, after which he made a sort of thick wash or paste, as follows: 1 quart soft soap, 1 quart fresh slaked lime, and ½ pound tobacco, boiled together in 1 gallon of water. With this wash he painted every every part of the stump, then grafted it with healthy scions. This treatment was effectual on that tree, and it now has a nice young top again, six to eight feet high, and no lice on it.

The trees near this tree just described had but few lice on them when the Dr. cut down the Sweet June; therefore, he scraped off all the scales or eggs that he could find, before the time for them to hatch, and washed or painted their trunks and branches (there were only two others) with the same compound used on the stump. But he discovered last spring that they were not all killed, as he had thought, but were multiplying very fast, and extending to other trees on his lots. (He lives in town, and has only a few dozen trees on his lots, consisting of apple, pear, cherry, plum, apricot, etc. He informs me that there are none on the trees in his young orchard on his farm, adjoining town, nor any of his neighbors' trees, that he can learn of). He says that the lice, after hatching out last spring, spread to his pear, plum and apricot trees — all being close by — and killed one young apricot tree, and injured a dwarf pear tree very much, by sucking the sap out of the leaves from the under side, where they were so abundant as to completely cover the under surface of every leaf, causing them to dry up as if parched by fire.

To-day I examined many of the trees on his neighbors' grounds, but found none, except on one apple tree in Mr. Matthew Woodruff's orchard, about thirty-five or forty rods north-east of Dr. Martin's infested trees. They are quite abundant on this tree of Mr. Woodruff's. Of course I refer to eggs at this season of the year. I examined the eggs with a microscope of 45 diameters in power. The eggs were all, with two exceptions, out of thousands, perhaps, clear, white, and perfectly sound.

Dr. Martin was of opinion, before I showed him the sound eggs to-day, that he had destroyed their vitality by medicating the trees last summer. He did it thus: By boring a hole into the trunk at the surface of the ground, then filling the hole with a compound of equal parts of sulphur and bromide of potash, and then corking up the hole tightly. He thinks it enters into the sap, and the circulation carries it to the leaves, and kills the insects. I have no faith in it. I think the safe way is to cut the trees down, or at least, cut off all the branches and burn them. I never knew any benefit by trying to force obnoxious or poisonous substances into the circulation of sap in trees, to kill or drive away borers, caterpillars, or other insects, and I have known or heard of such trials all my life.

The trees are all covered at this time with a heavy ice, caused by the recent sleet, which makes it difficult to examine them. I hope there are no others but those mentioned; but a gentleman to-day told me he believed he had them on one of his apple trees, about two miles south-west of Kahoka. I hope he is mistaken, but still I fear they may be there. [Afterward ascertained to be the native white species, *Harrisii* Walsh — C. V. R.]

Dr. Martin requested me to urge you to come up as soon as possible, and give them your personal inspection, and suggest some remedy by which he can, if possible, save his trees.

Please do not fail to come up before the eggs hatch next spring. Write to me and let me know just when you will be here, so that I and the Dr. may be sure to be at home.

Yours for the public good,
B. P. HANAN.

CLARK CITY, Mo., Dec. 4th, 1873.

I shall certainly do all in my power next summer to try and check the spread of this scourge; and should this Report fall into the hands of others in the neighborhood of Kahoka, whose trees are affected, I hope such persons will be kind enough to inform me of the fact, and to give me as full particulars as possible.

Upon subsequent examination, Mr. Hanan could not find any scales on Dr. Martin's plum and apricot trees; but some of the pear twigs which he sent me were sparsely covered with scales. These scales were invariably in a transverse position to the axis of the twig, and usually between the natural transverse rugosities, so as to be easily overlooked; and they were, furthermore, smaller and evidently less thrifty than on the Apple, as was shown by the unhealthy condition of their eggs, which were few in number and mostly dead and discolored, though no evidence of violence from mites or other enemies could be detected.

The third conclusion — namely, that the insect could not thrive in the southern half of the State — was, unfortunately, an erroneous one; for though apparently incapable of living in St. Louis county, this louse has in reality a much more southern range, being found in at least one county in the extreme southern part of the State, and even in Mississippi and Georgia.

In Colman's *Rural World* for October 15th, 1866, (p. 312), may be found the following paragraph:

FROM HARTVILLE, MO.

N. J. Colman, Esq.: The lice are utterly destroying the best apple orchards in this county. They seem to start on the trunks of the trees, spreading rapidly over the branches, and then on the apples—killing large trees in two years. Orchards on land descending to the north are more subject to them than when planted on other land. Some men in this neighborhood have tried every remedy they could hear of, without effect, so far. What is an effectual remedy against them?

R. B. PALMER.

It was in supposing that this communication referred to the native white species known as Harris's Bark-louse (Rep. 1, p. 7) that I erred; for it was in reality the Oyster-shell species to which reference was had. Such false inferences would be impossible if correspondents were more explicit! From facts given by Mr. Wm. Palmer, of Hartville, to whom I am indebted for many kindnesses, it appears that these scales were first discovered, as much as twenty-five years ago, in the southern part of Wright county, on some trees obtained from New York. They spread in a circuit of four or five miles, and destroyed several orchards, but have been dying out of late years, as several newly planted orchards, within the circuit, are uninfested and thrifty. They first were noticed in his own orchard in the year 1860, and have more or less infested eight hundred fine trees, though they have, for the past two years, been perceptibly on the decrease, and were scarcely to be found on the new growth of 1872. Why this bark-louse flourishes in Wright, and dies out in St. Louis county, is not easy of explanation. It may be owing to the occurrence of enemies in the one which do not occur in the other; but it is more likely owing to the fact that in Wright county the infested orchards are situated on the Ozark Mountains, where the climate is exceptional, and more resembles that of the northern half of the State—that, in short, the isentomic conditions, which otherwise limit the southern range of the species to a higher parallel, there occur as an exception.

ITS RANGE SOUTH.

Facts still more interesting and unlooked-for, regarding this insect's distribution, are, however, to be given. It not only thrives on the 37th parallel, when the conditions are favorable; but actually flourishes below the 33d, as I have received it from Carthage, Leake county, right in the center of Mississippi, where it has done much damage, *and is double-brooded!* In July, 1870, Mr. J. W. Merchant, of Carthage, wrote to me that he was satisfied the insect was found there, and that he had, the winter previous, cut down and burned about 200 apple trees that were infested with it. Upon expressing

doubts as to the possibility of the species thriving there, Mr. Merchant soon gave me proof that he had not been misled, and among other communications which he was kind enough to make, I give the following for the facts it contains:

Dear Sir: I have taken the trouble to ascertain something with regard to the depredations of the Oyster-shell Bark-lice in this part of the country. I first went to Mr. Wm. Hendrix, who has had them longer than any one else I know of. He informed me that they had been very bad in his orchard; but that they had, now, nearly disappeared. He thought he had one tree, however, which was still liberally supplied with them; so we went to that tree; but, lo and behold, they had disappeared from it also. I found a few, however, on another tree near by. Mr. Hendrix informed me that he had discovered the lice in his orchard at least ten years ago. He first found them about the center of his orchard, from which they spread very rapidly, until they covered all his trees—many of which they killed. Finally, they began to disappear, and last spring he could only find them on one tree, which he trimmed closely by cutting off the infested branches; and he then scraped off all the "shells" that he could find. This is the tree we first went to, which resulted as stated above. Mr. Hendrix has grafted pretty extensively for his neighbors, taking the scions from his own orchard; and by this means, I suppose, the lice have been spread, but to what extent I can not tell. I next went to J. D. Eads, as I had heard that his orchard had been ruined by the Bark-lice. He informed me that they had been in his orchard and remained there in "force" until his apple trees all perished, when they became scarce; but he has a few on his pear trees yet. He thinks they will not hurt pear trees. I next saw Mr. Howard. He said he could show me any amount of Bark-lice; but we looked over one orchard and found none—that, too, where there had been "plenty" of them. We then went to another place, and you can judge, by the limbs I now send, whether or not we found Bark-lice. I saw "shells" on several trees here. Finally, I went to Dr. J. L. Plunckett; he carried me over his orchard, and I saw more "shells" in his orchard than anywhere else. The lice are on a great many of his trees. I found even the apples on one tree covered with "shells." Mr. Hendrix informed me that he had seen the Bark-lice in the woods on Black-gum Elm, and perhaps other trees. He has never found any effectual remedy for Bark-lice except sulphuric acid, and that is only effectual when applied without dilution. Eads expects to keep them from his young apple trees by frequent applications of soap-suds. Howard thinks an application of potash is beneficial, and that carbolic acid "does the work for them." Mr. Hendrix says there came a late frost one spring, and the Bark-lice have not been bad in his orchard since.

J. W. MERCHANT.

CARTHAGE, MISS., *September* 8th, 1870.

Later advices from Mr. Merchant inform me that it has done great damage to the orchards in Attala county.

It also occurs in Georgia, and I have received the identical species from Mr. J. Rufus Rogers, of Waynesborough, Burke county, with the following history:

"In 1860 I got from a neighbor two sprouts (winter variety). They did well for a year or two, when I noticed the insects on them. In 1869 I cut and burned them, and set 75 young trees on the same land. In 1871 I noticed that the insect had again made its appearance on my young trees, commencing on trees nearest the old stumps. They spread very rapidly, and increased very fast, and my orchard, once the finest in this part of the country, is now well-nigh ruined. The trees stop growing, and the fruit rots. I know of no other trees in this vicinity infested with the lice."

Judging from the specimens sent, the lice are not in the most thrifty condition, for few eggs were found that had not been injured by mites; and there were evidences that some little Chalcid, and perhaps the one described further on, had been at work upon them.

Is this occurrence so far south, of what we have had good reason to consider a comparatively northern insect, to be looked upon also as exceptional, or will the insect be found, upon investigation, more generally spread through the Southern States? These are questions to which satisfactory reply is, at present, impossible. From all I can learn, there is nothing exceptional in the country, either around Carthage or Waynesborough; and we may conclude that the bark-lice will thrive in any parts of Georgia and Mississippi, or of the other Southern States. It is an interesting fact, however, as I learn from elaborate meteorological data furnished by Mr. Merchant, and covering a period of 25 years, that the mean temperature of the months of May – October, inclusive, is, at Natchez, Mississippi, lower than that of the same months at St. Louis while, as every one knows, the other months have there a much higher mean temperature than here. It is possible, therefore, that the great height which the thermometer reaches in the latitude of St. Louis, is prejudicial to the Oyster-shell Bark-louse, and precludes its flourishing in this latitude, while it lives and thrives to the north and south of us. At least, I can now give no other explanation for the peculiar geographical distribution of the species.

ITS SPREAD WESTWARD.

It has already obtained a foothold in several orchards around Lawrence, Kansas, having spread from trees originally brought from Ohio.

BOTH SINGLE AND DOUBLE-BROODED.

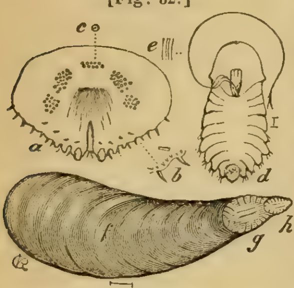
Not the least interesting feature of the southern range of our Bark-louse is its double-broodedness there. In Wright county, Mo., though the young hatch only a month earlier than in North Illinois—or about the first of May—it is nevertheless double-brooded, according to Mr. Palmer; and in Mississippi I know there are two generations each year, as I have received the second brood hatching about the first of September. Dr. Harris, years ago, asserted that there were at

least two broods of this Apple-tree Bark-louse each year, and, though he was evidently in error, so far as his own particular State (Massachusetts) was concerned, and has been severely berated for the statement by subsequent writers, yet it finally appears that his language is not so very wide of the mark!

TRUE NATURE OF THE SCALE, WITH ADDITIONAL PHYSIOLOGICAL FACTS.

Not to repeat the views formerly entertained by Mr. Walsh, Mr. Shimer and myself, as to the nature of the scale, it is only nécessary to state that my own opinion, that it is a secretion analogous to that which is so generally characteristic of the *Homoptera*, has now become a conviction, and is fully supported by the study of this and allied species. If we look at the common "Mealy Bug," (*Coccus adonidum* Linn.), and take notice how the mealy matter is secreted from the general pores of the body, but more especially from the sides and around the anus, and then imagine this secretion to be more attenuated and more glutinous, and to harden and thicken at the periphery, so as to confine the louse, and cause it to add more and more behind, as it requires more room, we shall get a very good conception of the manner in which our Bark-louse scale is formed.

[Fig. 32.]



The newly hatched louse (Rep. 1, Fig. 2, *2*) is oblong-oval, 0.01 inch long, rather more than half as wide, and one-fourth as thick. It has antennæ in which may ordinarily be traced 7 joints;* legs having a short, one-jointed tarsus, a more or less distinct, but soft claw, and, among other hairs, four at tip, which are knobbed, the upper pair somewhat longer than the lower. The end of the body is bilobed, and furnished with two long hairs or setæ. Except a deep yellow spot near each end, the color is yellowish-white.

As soon as fixed, there exudes, from the surface of its body, a white waxy powder, which at first is seen in the form of threads, (Rep. 1, Fig. 3, *3*), but soon becomes homogeneous. In the formation of this scale I have seen, in this species, quite coarse filaments extending on to the twigs, and in other species I have seen a waxy precipitation, covering the twig for some distance from the insect. This secretion is easily rubbed off or dissolved in alcohol or ether, but if undisturbed, forms a thin fibre on the thickening skin-covering. In a few days the first molt takes place, not as in the ordinary manner with insects, by a series of contractions and extensions which work the old skin to the end of the body from which it is finally freed, but

* The 8-jointed figure in my first Report is evidently a mistake, caused by the use of too feeble resolving power, as I have not been able to detect 8 joints in specimens examined more carefully since.

by a sort of loosening and shrinking of the body underneath—all the members, except the proboscis, being shed and abandoned with the skin. Strengthened by the secretions from the body, this skin forms the larval or first scale, (Fig. 32, *h*), and the cast-off antennæ are more or less easily discerned, as are also the intersections of the body. The legs and anal setæ are more thoroughly obliterated, though, by proper manipulation, traces of the former may be found.

For the sake of precision, let us now first trace the growth of the female, and afterward that of the male. As the now memberless and underlying body increases so as to crowd against the inner wall of its carapace, the latter is lifted up at its hind end, and the second or medial scale is soon secreted, as already illustrated (Rep. 1, Fig. 3, *4*). Presently, the skin is shed a second time, and mingles with the second secretion, which thus takes on the form of the body, and shows the insections almost as plainly as in the first scale (Fig. 32, *g*). In a short time this second scale becomes too small, and as the inclosed body needs more and more room, this scale, in its turn, is lifted up behind, and the third portion, or shield proper, (anal sack of Mr. Walsh), rapidly forms, by a series of increments, and soon acquires its final shape, which varies considerably, according as the lice are crowded or not, but has more often that of an elongate oyster-shell, and, upon close examination, is seen to consist of about a dozen more or less distinct eccentric layers or strata (Fig. 32, *f*). It is not known whether the female sheds her skin more than twice, but there is no evidence that she does. As pregnancy advances, she loses the jug-shape of her earlier days, (Rep. 1, Fig. 3, *5*), and becomes more rounded and swollen (Fig. 32, *d*). If carefully examined, the proboscis, which is easily overlooked on account of its fineness, will be found to consist of a long, thread-like organ, originating from a tubercle on the anterior, inferior surface, (Fig. 32, *d*). I have often succeeded in extricating it entire, and the end may be seen to be tripartite, though in reality the whole is composed of four pieces.* It is undoubtedly tractile, and, when once inserted, extends, perhaps as much from pure growth as from effort on the part of the animal, for it certainly has no such length in the active larva as it possesses in the adult female. It seems to be the seat of a good deal of nervous force, and quite strong, as it is capable of a serpentine and jerking motion, and when the scale is raised, frequently retains the louse, and prevents her falling to the ground. It is, perhaps, not thrust straight into the bark, but runs just under the more delicate epidermis, in a line with the body of the louse; for such is the case with the White Pine-leaf scale

*In former years this sucker was overlooked by myself, as well as by others, though we knew from analogy that it must exist. After the eye is once trained in special search for it, this sucker may be seen even with a good lens, and appears corneous and darker than the body. If not broken off, it is longer than the body, and though usually but three ends can be seen, I have been fortunate enough to separate and discern four pieces close to the base, the two upper corresponding to the upper jaws, (*mandibulæ*), and the two lower to the lower jaws (*maxillæ*).

presently to be treated of, as Dr. LeBaron has already recorded, (Ills. Rep. 1, p. 30), and as I have myself observed.

We shall also notice that the abdominal joints are each furnished at the sides with two or three spines or stiff hairs, and, upon still more careful examination, we shall find the principal pores through which the substance of the scale is secreted. These have very naturally been overlooked, in the past, by myself and other authors, for they are only visible with great care in the preparation of the specimen, and under the highest microscopic power. I feel quite convinced, from my studies of this and allied species, that a secretion, so subtle and attenuated as to be invisible, emanates from the general surface; but as is the case so generally with the insects of this and allied families, the bulk of the matter which forms the scale, and particularly the anal portion or shield, is secreted by visible pores upon the posterior portion of the body, and which may be noticed at the intersections of the abdominal joints, but more conspicuously in sets just under and around the anus. These anal sets of pores, or secretors as they may be called, are found to vary in position and number according to the species, and have been made use of by Targioni and Signoret to separate supposed species which are otherwise not easily distinguishable. The number of pores in the different sets is not, however, constant, as will be seen from the description at the close; and should not, therefore, be too much relied on when unaccompanied by other differences. After careful examination of several specimens of our apple-tree species, I find the median set to consist most commonly of 10, the upper laterals of 20 each, and the lower laterals of 14 each (Fig. 32, *a*).

We thus see that the larval and medial scales differ materially from the anal shield, in that the two former are composed in part of the shed skins, while the latter is a pure secretion. From the extreme fineness of the threads from which it is formed, they are invisible to the naked eye, and so easily ruptured that the louse always appears separate from its shield when the latter is lifted. Yet, with a good lens, the anal threads may sometimes be seen, especially in the pine-leaf scale to be treated of; and, strictly speaking, the louse is truly separated from its shell only when the latter is completed and oviposition begins.

We will now trace the growth of the male scale. Up to the formation of the larval scale, there is no perceptible difference between the sexes, but henceforth they are readily distinguished. In the male there is but one other scale formed, and this corresponds not to the second scale of the female, but to the anal shield. It is about twice the length of the larval scale, and though there is a distinct conchoidal fracture toward the end, which would indicate a short period of rest during its formation, no insections or traces of shed skin can be found. Under this shield the louse gradually becomes a pupa, the

members budding out, and the delicate larval skin being gradually loosened and detached; when, very soon after, the third molt takes place, and the winged insect retreats from the hind end of his little tenement and seeks his dissimilar mate, who is by nature forever debarred from enjoying the same aërial liberty.

The male covering differs essentially, therefore, from that of the female, not only in being of much smaller size, but in lacking the medial scale. The anal shield seldom exceeds twice the length of the larval scale, while in the female it sometimes extends six or seven times the length of the larval and medial scales together. It is, perhaps, a little more truncated behind and straighter than in the female, of finer texture, and of lighter and brighter color; otherwise, it has the same form (Fig. 31, *c*). I have found it quite abundantly both on the upper and under sides of the leaves, especially along the midrib; and though it is also found associated with the scales of the other sex, alike on the more succulent and the harder twigs, especially when thickly covered, yet the leaves seem to be its natural dwelling-place. The female, on the contrary—in that part of the country, at least, where there is but one annual brood—seldom settles on these deciduous organs; were she to do so, there would be no security for her eggs, which would drop with the leaf to the ground and perish. How wonderful must be that power which guides the new-born atoms, and allows the short-lived male to wander on to the succulent leaf, while it wisely prompts the female to remain on the more permanent twig! Nor is the wonder diminished in the least, whether we believe the power to be direct from the Supreme and Infinite, or—after finding that it is fallible, and that the female sometimes commits the *faux pas* of settling on the deciduous leaf and fruit, while the male often settles on the twigs—indirect through inheritance and congenital habit! The respective actions being by no means constant, the instinct prompting them can not claim infallibility, and may be accounted for on the principles of heredity, as there is a constant weeding out of all such females who chance to depart from those actions required to perpetuate their kind.

THE MALE LOUSE.

Though, from analogy, all authors have felt that the male of this bark-louse must have an existence, yet he has never heretofore been discovered or described. During the latter part of June and fore part of July I succeeded in rearing quite a number from scales from Mr. Palmer's orchard, and the ventral and dorsal figures which I have made (Fig. 31, *a b*) will convey a correct idea of this interesting little being. The wings appear whitish, and under a high magnifying power are seen to be covered with infinitesimally small hooks or bristles (*e*). The general color of the body is pale purplish-brown—not unlike the color of the shield which protected him—and, like the

other gentry of his family, he has no proboscis, (having lost it when shedding the larval skin), but near the place where it naturally would be are a couple of ocular tubercles, which give him the appearance of having four eyes—two above and two below. As Signoret has proved, and as may easily be seen by crushing the head, these tubercles are directly connected, by a pigmental substance, with the eyes, and they doubtless convey the power of sight; for the superior eyes can be of little service to the possessor as he crawls over the arched coverings of the other sex. The penis is about as long as the abdomen, and is protected and covered by two valves; and the hind wings are replaced by two fusiform balancers, which terminate in a long, delicate hook, and which hold and give strength to the front wings, which are spatulate in form and traversed with but two veins.

Frail and delicate as these little beings appear, they are yet possessed of wonderful nerve-force and wing-power; for the few days of life allotted to them are days of great activity, and in the breeding jar they keep up an almost constant wing-vibration, and are never at rest, except when the temperature is unusually low.

In his excellent account of the closely-allied Pine-leaf scale, Dr. LeBaron (Ills. Rep. 1, p. 88) gives expression to the following sentiment:

"Fixed immovably to the surface on which she reposes, and hidden from view beneath the shadow of her vaulted carapace, but dimly conscious, we may presume, of some unfilled requirement of her being, the helpless female *Coccus* awaits the addresses of her unknown and invisible paramour. Nor does she wait in vain. Of all the countless myriads of these lowly creatures which congregate upon the bark of the apple-tree, or whiten with their spotless phylacteries the foliage of the pine, not one, so far as we know, fails to be called to enact the offices of maternity. Nature, in the universality of her providence, takes them in her charge and ministers to their necessities, and no unloved or unfruitful virgin is permitted to languish in the halls of the *Coccidæ*."

However beautiful and even rational this view may be in the abstract, I have serious doubts of its correctness in point of fact, especially with regard to the Oyster-shell species. Nothing in the past history of this insect has been more noteworthy than the failure on the part of entomologists to discover the male. It is barely possible that this failure may be attributable to negligence and oversight, or that other circumstances may have contributed to it, such as the probable facts that the males hatch out earlier than the females, and that they are naturally less numerous — each being able to serve several females, as Reaumur found to be the case with another species. But with such careful observers as Walsh and Shimer, and with Dr. Le Baron himself, surrounded by infested trees at his home, in Geneva, it would hardly seem probable. When, also, I recall my own observations in past years, in Northern Illinois, and my attempts to solve the

riddle of his existence — when I recall the fact that he has likewise remained undiscovered by eastern observers, and that the males of closely allied European species are unknown — the impression becomes irrisistible that these insects are metagenetic, and that, just as in the closely allied plant-lice, (*Aphidæ*), they may and do go on multiplying agamically for a series of generations, and that the male only occasionally appears. To strengthen the impression, M. Signoret informs me that M. Balbiani absolutely denies that the presence of the male is necessary in the *Lecanides*, a subfamily of larger bark-lice. It would also seem that in accordance with what appears to be a very general law both among plants and animals,* the male is in some way connected with weakened vitality; for with the very batch of leaves and twigs from which I bred the ♂, came the statement that the insects seemed to be dying out, and were less injurious; and, certain it is, that wherever I have found the male scales on the twigs, it was always on such as were so thickly covered with the other scales, that these were two or three thick and many of them aborted. Moreover, it is well-known that this bark-louse has, during the past few years, become less and less troublesome in portions of the North-western States, which suffered so much from its injuries ten and fifteen years ago. It seems to have lost vitality, and in carefully examining some trees in the vicinity of Dubuque, Iowa, I had no difficulty, last August, in discovering a certain percentage of male scales. However, the question as to whether our Oyster-shell Bark-louse can multiply agamically, or not, is easily settled by a few simple experiments, which will doubtless be made by those who have the proper opportunities. Even believing, as I do, in agamic multiplication in this case, we may, nevertheless, naturally conclude, from analogy, that there is a limit to it, and that without occasional fecundation, eggs would eventually either become addled, or the female die without giving birth to them; and on this hypothesis we can account for the abortive scales which are often found without any trace of the contents having been destroyed by other agencies.

MODE OF SPREADING.

Having already (Rep. 1, p. 15) referred to this subject, I allude to it again only because a good deal of wonder has been expressed at the wide extent of this insect's range, considering that it is active but three or four days in the course of the year. Dr. LeBaron records some interesting observations, which show that the active larvæ are seldom blown by the wind more than three rods from the outermost branches of a tree, and he thinks that the theories so far propounded

* See Rep. 4, p. 65; also an article "On the Relation between Organic Vigor and Sex," by Dr. Henry Hartshorne, read before the Am. Ass. for Adv. of Science, at Dubuque, and partly copied in the *American Naturalist* for December, 1872; also *Gardeners' Monthly*, November, 1872, and *Old and New*, February, 1872.

are inadequate to account for the wide dissemination of the species. It is very clear to me, however, that by aid of winds and their natural powers of locomotion, the lice can soon overrun a large orchard from a given point; and their wide distribution is easily accounted for *by the transport of the female scales on scions and nursery stock*, to say nothing of the aid they get from birds, flying insects and even running water; for Dr. Shimer has shown that this last may, under favorable circumstances, serve as a means of transportation. Moreover, severe storms, passing over infested districts at the right season, may help to carry them still greater distances.*

FOOD PLANTS.

Besides the Currant, Plum, Pear, Crab and Persian Lilac,† there is evidence, as we see from Mr. Hanan's letter, that it will also live on the Cherry and Apricot, while the same, or a closely allied species, occurs on the Elm and Sweet Gum in Mississippi, according to Mr. Merchant; on the Mountain Ash, according to Dr. Shimer (Trans. Ills. State Hort. Soc., 1868, p. 228) and others; on the Dogwood (Am. Ent. II, p. 334), and on the Ash-leaved Spirea, according to Judge J. G. Knapp, in a paper read before the Madison (Wisc.) Horticultural Society, at its meeting in 1870. In Europe, what has been taken for the same species, is also found on the Dogwood, as well as on the Elm, White Thorn, Medlar and Currant.‡

The rule among the bark-lice seems to be that each species is restricted to plants of a given family, and future investigations may show that those existing on trees, which do not belong to the family *Rosaceæ*, have structural differences, and are distinct, notwithstanding their superficial resemblance. Such differences may be expected, as will be shown in the closing bibliological remarks. However this may turn out, it is very certain that the species in question, though partial above all things to the Apple, yet shows a preference for some of its many varieties, or at least thrives better on some than on others. Dr. LeBaron mentions the Red Romanite, Red Astrachan, Rambo, Early Harvest, Summer Rose, as being most largely infested, and the

* After a thunder storm in the middle of March, I saw the ground in places in St. Louis sufficiently covered with pollen to appear as though sprinkled with sulphur; and this pollen, upon examination, proved by its trilobed and oily character, to belong to some pine, and probably to the Long-leaved pine, which was at that time in bloom in the Southern States, and from which it must have been carried a distance of at least four hundred miles. This pollen grain is, though aided in floating by the lobes, heavier than the young bark-louse; and numerous other instances of the carrying power of severe storms are on record.

† The negative evidence is very strong that the species found on the Persian Lilac is distinct, for some of these shrubs, belonging to Mr. F. Starr, of Alton, Ills., are crowded with the scales, in the immediate vicinity of apple trees that have none. Yet from specimens of these scale-covered lilacs, received from Mr. Starr, and from others examined in other quarters, I can find no superficial differences which would enable me to distinguish the bark-lice thereon from the apple-tree species.

‡ Boisduval's *Entomologie Horticole*, 318; Taschenberg's *Entomologie fuer Gærtner and Gartenfreunde*, 430.

Northern Spy, Maiden's Blush, Benona, Soulard, Willow Twig, Lowell, and Limber Twig as most free — his observations being made principally in the orchard of J. W. Robson, of Galena, Ills., where the trees alternated and were similarly situated with respect to outside agencies.

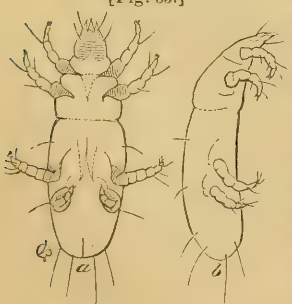
I once witnessed a very beautiful and striking illustration of this truth in an orchard belonging to Mr. A. M. Herrington, of Geneva, Ill. Though, as already stated, the scales are found upon the wild Crab, they are always so found in sparse numbers, which indicates that the wild apple is not so congenial to the species as many of the cultivated kinds. Mr. Herrington has an orchard of about a hundred Ohio apple trees, grafted on to crab stock, together with a few of the ungrafted crabs. Scales are found on the grafted parts of almost all the trees, but scarcely one can be found on the crab stock; and in a few instances the grafts are covered right down to the junction with the stock, but do not go beyond.

ENEMIES AND PARASITES.

Besides mites* and lady-birds, the latter of which make ragged holes through the scales, it has long been known that a little Hymenopterous parasite preyed upon this bark-louse, and in 1854 Dr. Fitch was familiar with its larva, and figured a scale that had been perforated by the mature fly.† It was not till the year 1870, however, that this fly was really known and described by Dr. LeBaron, who has given such excellent accounts of it,‡ that I prefer to quote his experience

* These mites may generally be distinguished from the young bark-louse by having eight legs instead of six, though some of them have but six legs in the larva state, and this criterion will not always hold. Moreover, in the 8-legged species the front pair are easily mistaken for antennæ. We must therefore look for other distinguishing traits, and we find them in the relative position of the legs, the third pair in the mites always being widely separated from the two front pair, while in the bark-lice they are all equidistant. The mites are also more transparent and polished than the lice. There are doubtless several mites which destroy the lice, and while one of the 8-legged forms has been described as *Acarus? malus* by Dr. Shimer, he has proposed the name of *A. Walshii* (Trans. Ills. Hort. Soc. 1869, p. 281) for the 6-legged form, but without description; and indeed descriptions, unless accompanied with habits, development and variation, amount, in these cases, to very little.

[Fig. 33.]



I present, herewith, (Fig. 33), a side and ventral view of the species which so effectually destroyed the contents of the Georgian scales, in order that the reader may get a correct notion of the appearance of these mites. It may be a form of the *Acarus? malus* of Shimer, but differs from his description in being almost four times, instead of twice, as long as broad, as well as in other details. The head and the limbs are yellowish, and more horny than the rest of the body, which is white. Four prominent hairs are seen from behind; and when the animal is crawling, a dorsal view discerns but six legs, the posterior pair being smallest and apparently of little use, as they are generally curled up, as in the figure (*a*). The ends of the legs are flexile, and are spread out in the form of discs in the act of walking. It apparently belongs to the genus *Dermaleichus*.

† N. Y. Rep. I., p. 35.

‡ *Am. Ent.* II, pp. 360-2: 1st Ills. Ent. Rep. pp. 34-9.

in his own words; especially as I have had no opportunity of making personal observations upon it. It belongs to the extensive family

[Fig. 34.]

Chalcididæ, which comprises insects of small size, characterized chiefly by their jumping power and parasitic habit. The species in question was described (*Amer. Ent.* II, p. 360) under the name of *Aphelinus mytilaspidis* from the female sex only, the male being yet undiscovered. Her habits are thus recorded by Dr. LeBaron:

In the course of a series of observations upon the Apple-tree Bark-louse, during the past season, it has been my good fortune to trace the history of this interesting little insect, which, if it has ever been seen before, has not been identified, and whose very existence has been only a matter of inference from the visible marks of its beneficent operations.

In the early part of the season, while examining the lice upon an apple tree, I noticed two or three little yellow Chalcides running along the infested twigs, which I conjectured might be the parasites of the Bark-louse, but had no proof that this was the case. But about the first of August, upon raising one of the scales, I happened to uncover one of these insects in the last stage of its transformation. Its wings were not yet unfolded, but it ran so rapidly that I had some difficulty in keeping it within the field of the lens. As soon as it paused long enough to be examined, it was easily recognized as a Chalcis by its general aspect, and especially by the peculiar vibratile motion of its short geniculate antennæ.

Having once become familiar with its appearance, I have had no difficulty in capturing, in the latter part of August and September, all the specimens I desired on the infested trees. I have repeatedly watched the female Chalcis in the act of inserting her ovipositor through the scale of the Bark-louse, for the purpose of depositing her egg in the cell beneath. She always places herself transversely with respect to the scale. Sometimes she mounts upon it, and then her tiny body is seen to be considerably less in length than the width of the scale. Usually she backs up upon it only so far as to bring the tip of her abdomen about opposite the middle of the scale. Then bringing her ovipositor down perpendicular to her body, she forces it through the scale by a series of boring or short plunging motions. Having accomplished this, she remains stationary for many minutes, while by some invisible intestine motion the egg is carried down the ovipositor and deposited beneath the scales. So absorbed is she in this delicate operation, upon the successful accomplishment of which not only her own hopes, but those of the horticulturist, so largely depend, that nothing can deter her from it. In one instance, having drawn down a branch of an apple tree, I discovered a *Chalcis* in the act of depositing. While holding the branch in one hand, and viewing the insect through a lens held in the other, the branch slipped through my fingers and flew back with violence to its place. Drawing it down again, the twig I had hold of broke, and it flew back a second time. I supposed that that observation had, of course, been brought to an abrupt termination. But, upon drawing down the limb the third

time, there stood my little *Chalcis* as immovable as a statue at her post. She may be touched with the finger while thus engaged, or even crushed, as I have often inadvertently done in my attempts to capture her, but nothing short of this actual violence can move her from her position. With such wonderful perseverance and devotion do these living atoms of creation perform their allotted part in the complicated economy of nature.

The egg thus deposited hatches into the little footless larva previously mentioned. This larva is so admirably described by Dr. Fitch, in a single sentence, that I can not do better than copy his description: "Under these scales I have repeatedly met with a small maggot, three-hundredths of an inch long, or frequently much smaller, of a broad oval form, rounded at one end and tapering to an acute point at the other, soft, of a honey-yellow color, slightly translucent and shining, with an opaque brownish cloud in the middle, produced by alimentary matter in the viscera, and divided into segments by faintly impressed transverse lines." (Fig. 34, *c*.)

The only motion of which this small grub is capable is a slight extension and contraction of its body, particularly at the two extremities, by which its form is correspondingly modified.

There is usually but one larva under each scale, and I have never seen more than two. In the earlier part of the season it is seen adhering to the body of the Bark-louse, but later it is found in the midst of the eggs or their remains.

The Chalcis-fly itself is a beautiful object under the microscope. Its length is a little less than half a line, or about one-twenty-fifth of an inch, though I have captured a few specimens considerably smaller, being but little more than one-third of a line. I at first supposed that these smaller individuals were males, but all the specimens that I have examined have proved to be females. Their color is a uniform pale lemon yellow. The only variation from this color is in the minute mandibles, which are reddish brown. There are three coral red occelli on the summit of the head, and the ovipositor, which lies in a groove on the underside of the abdomen, exhibits a slight reddish tint. The wings are thickly beset, over nearly their whole surface, with bristly points, and their margin is ornamented with a long fringe.

But a better idea of the appearance of this little insect will be obtained from the magnified figures which accompany this article (Fig. 34 *a* showing perfect fly, *b* the greatly magnified antenna, and *c* the larva) than from any verbal description.

By observations, made as late as the first week in November, the opinion is confirmed that the Chalcis of the Bark-louse has two broods in a year. By the middle of September we find many of this year's scales pierced with the round holes through which the first brood of Chalcides has escaped; and late in the fall we find, under about an equal number of scales, the fully-grown larvæ of the second brood, sometimes with the eggs of the Bark-louse upon which they have subsisted all consumed, and sometimes with a few remaining; and in this state they undoubtedly pass the winter. This second brood must appear in the winged form early enough next summer to deposit the eggs from which the first brood of next year will proceed.

Dr. LeBaron found that in 1870, in different orchards in DuPage county, Illinois, only one in fifteen of the scales examined contained healthy eggs—so effectually has this little *Aphelinus*, assisted by other enemies, such as mites and lady-birds, done its work

This little parasite, which works for the most part unseen but none the less effectually, and which so materially aids man in protecting his apple-trees, is, fortunately, easily introduced into sections of the country not yet favored with it, and may, no doubt, be colonized wherever its natural prey flourishes. The second brood sleeps away the winter in the larva state, sheltered by the scale intended to protect the bark-louse eggs; and twigs thus freighted with our little sheltered friends may easily be carried from one part of the country to another, or even to a foreign land. The torpid condition of the larva will insure its safe transportation in winter, and its presence may not only be surmised by the smooth holes in the deserted scales which are found in orchards where this *Aphelinus* abounds, but may be positively ascertained by careful lifting of a few parasitized scales. To colonize the parasite, all that is necessary is to tie such parasitized twigs on to trees which it is required to protect, and the microscopic flies will issue at the proper season and carry on their good work, unconscious of the carrying process which man had submitted them to during their larval dormancy. Dr. LeBaron has already made some efforts to introduce this parasite around Galena, Ills., where, as he ascertained, it did not previously occur; and I shall take steps the coming season to introduce it into Clark and Wright counties in our own State.

REMEDIES.

I have little to add to the advice given in 1868. The importance of critical examination, before planting, of all young trees and scions, or of applying some simple remedy when the young lice are hatching, can not be too strongly urged; and, as a rule which will hold very generally true, it may be stated that the young begin to hatch just about the time the blossom falls and the fruit begins to set. Let those who prefer to work toward eradicating the pest in winter time (as many no doubt will, on account of the leafless state of the trees and the greater leisure which most fruit-growers have at that season) vigorously prune and scrape the infested trees; and afterward apply some of the oily applications previously recommended. As a remedy not previously named, I would mention linseed oil, which has been used with marked and beneficial results in Grundy county, Ills. Many persons have been deterred from using greasy or oily substances on their trees from a fear of evil consequences resulting to the trees; but there is nothing more certain than that, judiciously applied in early spring after the sap begins to flow, these applications do not injure trees; while they are effectual, more especially when applied at such season or during thawing weather, in killing the eggs under the scales—the oily particles being absorbed through and under the scales, and destroying the eggs as soon as touched. The following experiment, performed by Dr. LeBaron, and which I quote from his second Report, will give confidence to the hesitant:

"On the 30th of March, the buds not having yet expanded, I selected six thrifty five-year-old apple-trees, of three different varieties, and applied to two of them simple lard, greasing over every part of the trees, trunk, branches and twigs. To two others kerosene oil was applied in the same manner. To the other two linseed oil was applied; but in this case, to vary the experiment, the terminal twigs were omitted. None of these trees were eventually damaged by the applications. Upon those to which the lard and linseed oil were applied, no effect was perceived. They leafed out as early and looked as well as other trees standing beside them. The kerosene, as might have been anticipated, acted more severely. It killed or seriously damaged all the first buds, and the trees were several weeks later in leafing out than the others; but at an examination of them on the 5th of July, no difference could be seen in the quantity or healthiness of the foliage from that on the other trees. One effect of the kerosene is deserving of notice. The check thus given to one of these trees had an effect similar to girdling or root-pruning, namely, that of throwing it into premature bearing—this tree producing an apple though still standing in the nursery row.

Mr. Palmer has used hot lye, applied with a brush, soon after the lice hatch, to the trunk and limbs as far as he could reach, with good results. The injury to the foliage is only temporary.

BIBLIOGRAPHICAL AND DESCRIPTIVE.

Generic Name.—This insect, ever since the publication of Dr. Asa Fitch's first N. Y. Report, has been known, in American entomology, by the technical name of *Aspidiotus conchiformis* (Gmélin). The genus *Aspidiotus* was erected, in 1833, for those species living *under* a scale, by Bouché, a German entomologist; and our insect has been referred to it; but this author paid little regard to the work of those who preceded him, and the genus *Diaspis*, which covers the characters of *conchiformis*, had already been erected by Costa in 1827. Costa's name, therefore, has priority, though his observations were superficial and unreliable. In 1868 (Trans. Am. Ent. Soc., Vol. I, pp. 361–374) Dr. Henry Shimer, of Mt. Carroll, Illinois, proposed still a new genus, (*Lepidosaphes*), and even a new family, founded on certain characters of this insect. Dr. Shimer appears to have been unacquainted with the work that had been and was being done in the same field by other authors. His generic name might have been adopted, had not another genus already been erected for it, and employed by Targioni and Signoret. As for the other characters mentioned by Dr. Shimer, and supposed to be of family value—viz: (1) the scale constructed by, and separated from, the insect; (2) no tarsal claw; and (3) the possession of *digituli*—they are easily disposed of. (1) The separation of the scale had already suggested to Bouché his genus *Aspidiotus*; (2) the tarsal claw I have plainly seen, and though blunt and soft in the larva, it is quite conspicuous and more perfect in the male;* (3) the digituli, or knobbed hairs, are common

*See Fig. 31, *d*.

attributes of the *Coccidæ*, and precisely similarly knobbed hairs are found at the antennal extremities of some species—e. g. *Lecanium aceris* (Schrank), *auctore* Signoret.

Mons. V. Signoret, of Paris, has lately been engaged on an elaborate monographic revision† of the insects of this family. This distinguished author has, perhaps, devoted more time to the *Coccidæ* than any one living; and in his admirably illustrated essay, with copies of which he has favored me, the *Coccidæ* are divided into four distinct subfamilies, distinguished by the more obvious characters, as follows:

1.—Diaspides:—*Species covered with a scale composed of successive moltings, and of a secretion forming a shield or sack more or less independent of the body of the animal.*

Nine genera are included in this subfamily, but the scales may all be reduced to two principal types, viz: Those with rounded shields, like an oyster-shell, with the larval scale in the center; and those with more lengthened shields, in the form of a large comma, or of a muscle-shell, and having the larval scale at one end.

Among the latter is the genus *Mytilaspis*, to which our apple-tree species, under consideration, belongs, and which is characterized by the male and female shields having much the same form.

2.—Brachyscelides:—*Species living in gall-like or tube-like excrescences.* These insects are, so far as known, confined to Australia.

3.—Lecanides:—*Species either naked or inclosed, or simply covered with waxy, calcareous or filamentous secretions; and in which the female, after fecundation, generally acquires an entirely different form to that which she previously possessed, and becomes fixed. Before pregnancy, they have the power to move, if necessary.*

A number of genera are included in this subfamily, some of which, approaching in some characters to the *Diaspides*, have been separated by Targioni, under the name of *Lecanio-diaspides*.

4.—Coccides:—*Species retaining to the end the body-form, with all its joints distinct. They never become necessarily fixed, and are either naked or more or less covered with waxy or spumous matter, arranged generally in filaments.*

Specific Name.—In considering the specific name of this insect, we meet with the same difficulty which constantly presents itself to the conscientious student of animal life, especially in its lower forms; and there can be no stronger argument in favor of the mutability of species than this difficulty experienced in properly defining them. All nature is a whole, and our classificatory divisions, though very essential to enable us to study and understand her, have hardly a more real existence than the divisions by which we measure time. With partial knowledge, only, of her facts, it is easy to separate and draw distinctions in the cabinet; but deeper knowledge of these facts often begets doubt and difficulty, as to these distinctions, and shows the unnaturalness of strict and fast definitions.

With our bark-lice, as already stated, it has been customary to consider the forms found on different plants as distinct species. No

† *Essai sur les Cochenilles*, in *Annales de la Soc. Ent. de France*, commencing in 1868.

other course could well have been taken, considering our imperfect knowledge of them in the past; but it is evidently a very artificial one. We now know that some of the larger species thrive on plants of widely different families, and a correct knowledge of the present relations of these bark-lice will first be had, when, by prolonged experience and deeper search, we understand all the more minute structural differences; the variation resulting from phytophagism or cause whatsoever, and the male as well as female characters.

It has generally been supposed that our Oyster-shell Bark-louse is the same species originally mentioned by Reaumur, in 1738, (Mem. Tom., IV, p. 60), and found in Europe on the Elm. Doubts have existed as to the identity of the two, because of the difference of food-plant; but his account and description of the insect itself agree otherwise with ours. In 1762 Geoffroy described a species supposed to be the same, by the name of *arborum-linearis*, and twenty-six years afterward Gmélin gave the name *conchiformis* to what has also been considered the same insect. Geoffroy's name has been very generally ignored, because of its non-conformity to existing rules of scientific nomenclature, and of the inappropriateness of the term, if intended for our apple-tree species. In 1851 Bouché (Stett. Ent. Zeitung XII, No. 1) gave to a similar species, occurring on the Apple in Europe, the name of *pomorum*, which has either been considered synonymous with the others, or entirely ignored by most subsequent authors. Signoret, in the second part of the essay already referred to, considered all these names synonymous; but he subsequently changed his mind, and in the sixth part of his essay he has employed each of the three names for what he considers distinct species, and has characterized them as follows:

M. linearis (Geoff.) is found on the Linden, and is supposed to differ from *conchiformis* by the shield being long, more or less straight, of a yellowish-brown color, and generally covered with a soot-like substance; by the female being nearly as broad before as behind, and by the secretors on the anal plate being nearly continuous, the middle set with 6 or 7, the upper laterals with 10 or 12, and the lower laterals with 9 or 10. The ♂ is unknown.

M. conchiformis (Gmélin) is the species found on Elm, and which differs in no respect from the apple species, except in the number of anal secretors possessed by the female, the median set composed of 6 or 7, the upper laterals of 8 or 9, and the lower laterals of 5 or 6. Signoret says that the male scale is of a pale yellow, and with straight and parallel sides, while the male is described, from a mutilated specimen, as pale gray, with the antennæ appearing short.

M. pomorum (Bouché) is the species found on Apple, and it differs from the preceding, principally in the median set of secretors in the female being composed of 17, the upper laterals of 17, and the lower laterals of 14. The eggs are described by Signoret as being of a *deep red*, and the antennæ of the active larva as 6-jointed. The scale has the same form, but is described as brownish-black, with a portion of the "apical border white and more oblong." Bouché, in characteristic German, describes it as ham-muscle-shaped (schinkenmuschelförmig), slightly bent, and with the pointed end, and edge of broad end, yellowish. He also describes the eggs as *red brown*, and mentions the food-plants as "Apple, Pear, Plum, Dogwood, etc."

It will be seen that in thus distinguishing these three species, M. Signoret attaches a great deal of importance to the number of anal secretors. Judged by this criterion, our own insect, under consideration, can not be referred to either species, and is consequently undescribed. The name being appropriate, it would have pleased me to refer it to Bouché's *pomorum*, and in the secretors it comes nearer to that than to the other species; but aside from the difference in the secretors, the difference in the color of the eggs is an insuperable objection, as I find this character the most constant. Noticing that in his generic diagnosis M. Signoret says that the eggs of *Mytilaspis* are always either white, yellowish or grayish, and knowing that those of our species, though normally pure white, become discolored and ferruginous when addled or otherwise injured, and are always yellowish just before hatching, it struck me that this author might have made a mistake in describing those of *pomorum* as "deep red." And, in fact, after examination of specimens of our insect received from me in 1870, he was inclined to think the two identical, and that he *had* made a mistake. But there is Bouché's original description, in which the eggs are distinctly described as red brown, and which effectually separates the two forms; and as *conchiformis* is properly relegated by Signoret to the species on the Elm, and may be considered distinct, not only on account of the differences indicated above, but of the negative evidence that our apple-tree species does not affect the Elm, there seems no other course left but to give our insect a new name. I have little doubt that the species occurring on the Apple in England, and treated of by "Ruricola" (Jno. Curtis) in the *Gardeners' Chronicle*, 1843, p. 736, under the common name of "Apple-tree Mussel-scale or Dry scale," and the scientific name of *Aspidiotus conchiformis*, is the same as our *pomicorticis;* for though the mother louse is described as "fleshy-green" and "yellow-green," the eggs are said to be white, and the size, form and habit otherwise coincide. The same may be said of the European apple tree species mentioned by Boisduval and by Taschenberg, who describe the eggs as white.

Now, these four bark-lice certainly bear sufficient resemblances to be mistaken for one species; and whether they really constitute but one species, merely varieties of one species, or four genuine species, according to the usual acceptation of the term, can only be definitely ascertained when the males of all are known, and when, by experiment, it is found that the one can not live upon the food-plants of the other. A slight difference in the number of anal secretors can not be looked upon as of sufficient specific importance when all other characters agree; for the number, as we have already seen, is not constant. Yet, there is no doubt a limit to the variation from the ordinary number, and the differences noted above probably have their value, and at all events are made by the highest authority. It will certainly facilitate our study to have these four insects separated, and

I shall, in future, always refer to our apple-tree species by the scientific name of *Mytilaspis pomicorticis*. On general principles, I dislike to change long-established names, but by doing so in this instance we not only brush away the cobwebs of uncertainty which have gathered around the nomenclature of the insect, but we also obtain more appropriate terms. All former descriptions were in so far imperfect and provisional that they lacked the male characters, and in thus connecting the name *pomicorticis* with this more complete description, I hope that our insect's title is secured. I have not thought best to change the popular name by which it is known, for though the term "Mussel-shell" would be more appropriate, the scale not unfrequently assumes an oyster-shell form.

MYTILASPIS POMICORTICIS, N. Sp.—*Eggs*—From 30 to 100 under each scale; length scarcely 0.01 inch, irregularly ovoid, nearly thrice as long as wide, snow-white, except just prior to hatching, when they become yellowish. *Larva*—Length of body 0.01 inch, ovoid, thrice as long as wide, pale yellow, with a darker yellow spot near each end; a few short hairs seen around border; two fine anal setæ about half as long as body springing from two lobes between which two spinous hairs are always seen; antennæ quite variable, the joints irregular and not easily resolved, sometimes appearing only 6-jointed, but more generally 7-jointed, with a few hairs, two or three at tip the longest and most persistent; legs with a one-jointed tarsus, a feeble claw, and, among other hairs, four more or less distinctly knobbed ones near tip, the two uppermost longest.

♂—Length of body, 0.022 inch; color, translucent carneous-gray; a dorsal transverse band on each abdominal joint, and portions of the mesothorax and metathorax darker, or purple-gray; the members somewhat lighter. *Head*, sub-triangular; rostrum rudimentary; ocular tubercles, one each side of it, plainly visible, the eyes on the upper surface prominent, dark, and with few facets; antennæ as long as body, 10-jointed, jts. 1 and 2 bulbous and sometimes indistinctly separated; 3—9 about four times as long as wide, slightly constricted; 10 half as long and fusiform; all but basal two with a whorl of about eight hairs, slightly clavate and as long as width of joint. *Thorax* very large, oval; prothoracic portion narrowing in front, composed of two transverse folds, the anterior one having a transverse row of four dusky dots; the mesothoracic portion large and elevated, showing three lateral swellings; a well-defined medio-dorsal plate, rounded in front, shallowly notched behind, with a medio-longitudinal suture, and a transverse one dividing it in two, the anterior half pale, the posterior darker; the metathoracic portion showing a sub-triangular scutel, and separated from mesothorax by the transverse band (*apodema* of Targioni). *Wings* about as long as body, arising from base of mesothorax, spatulate, closing flat on back in repose, and appearing whitish, finely and uniformly covered with short, stiff hairs; supported by a bifurcate vein, the bifurcation arising from basal fourth, and each fork running near and almost parallel with the wing-margins; balancers dark, with the hook quite long. *Legs* with the middle pair longest, and—from large size of coxæ—further from front than from hind pair; the coxæ and femora large and swollen, the latter with a more or less distinct lobe near the base below; the tarsi one-jointed, with a constriction occasionally indicated, and terminating in a single flexible claw, surrounded by four clubbed hairs; the tibiæ and tarsi are quite bristly, but on the femora there are usually but two bristles, one about the middle above, and one on the basal lobe below; the coxæ also have one above. *Abdomen*, seen from above, nearly as long as thorax; appearing shorter from below; 8 joints only discerned; the last joint abruptly narrowed into a large tubercle bearing four bristles on the under side, and sending forth the genital armor in the form of an awl-shaped style as long as the abdomen.

♂ Scale—Larval part golden-yellow; the anal shield yellowish-brown, sometimes quite pale, inclining to white, flattened, straight, rather more than twice the length of larval scale, increasing in width from tip to end, where it is slightly truncate; attached by a white film; average length, 0.035 inch.

♀—Average length, 0.05 inch; color, pale yellow; jug-shaped and flattened when young, more globular when mature, and twice as long as wide; the cephalo-thoracic portion rounded and entire, but narrower than the abdominal, at the juncture with which it forms a more or less conspicuous lateral projection; on its inferior side is a tubercle, having two longitudinal ridges, and giving rise to a corneous, filiform proboscis, longer than the body, and composed of four separate parts; posterior abdominal joints deeply lobed laterally, with two or three blunt, fleshy hairs to each lobe; anal plate gamboge-yellow, corneous, with an irregular border, presenting two larger, slightly tri-lobed, median projections, and one or more smaller ones each side, furnished with spinous hairs, two especially between the tri-lobed projections aforenamed; five more or less complete sets of secretors visible from below, arranged around anus in form of an arc, the median set with normally 10, the upper laterals 20, and the lower laterals 14; besides these, some six or more blunt tubes, and a series of shorter pointed ones, may be noticed along the border, and doubtless serve as secretors. (See Fig. 32 *b.*)

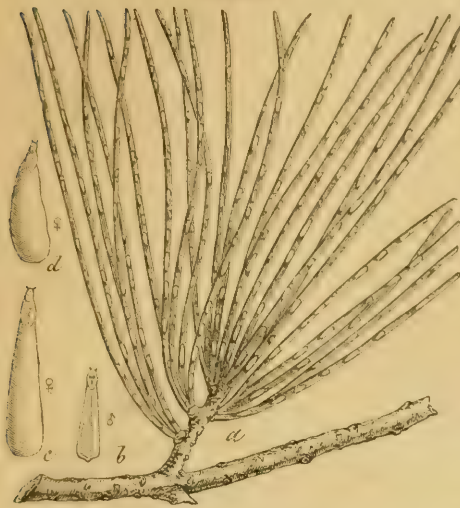
♀ Scale—Larval scale golden-yellow; median scale somewhat darker; anal shield varying from pale brown to deep purplish-gray, and generally of a color with the bark it is upon. The whole scale is often incanous, but the hoary film easily rubs off; it averages 0.12 inch in length, but is quite variable in form and size, being either straight or curved, narrow and strongly arched, or broad and flatter, but always rounded at the end; the white inferior laminæ at sides sometimes show distinctly from above, and give the appearance of a pale border.

The lice, whether ♂ or ♀, vary in appearance according to position and state of maturity. In making the foregoing descriptions and figures, I have taken what appeared the most natural positions, after examination of many specimens. The ♂ abdomen shrinks very much in drying, and the more detailed ♀ characters are variable. While the normal number of secretors in the middle set is never more than 10, I have sometimes found but 8 or 9; that of the upper laterals never surpasses 20, but may be as low as 15; while that of the lower laterals is more uniformly 14, though I have sometimes found 16, and at others 12. Opposite sets do not always contain the same number.

THE PINE-LEAF SCALE-INSECT—*Mytilaspis pinifoliæ* (Fitch.)

(Subord. HOMOPTERA, Fam. COCCIDÆ.)

[Fig. 35.]



There are several undescribed bark-lice—some of them quite interesting—which attack our forest and shade trees, and especially our evergreens; but for want of time to make proper descriptions and figures, they must be passed over for the present. An exception is made of the Pine-leaf Scale, because, first, it is the most common and injurious of them all; and, secondly, by coupling its history with that of the Oyster-shell species of the Apple, much unnecessary repetition is avoided; for notwithstanding the last named normally inhabits the bark, while that under consideration is confined to the leaves, the two insects belong to the same genus, and have precisely similar modes of development.

Many persons, who justly esteem the White Pine one of the most valuable of our ornamental, shade, and timber trees, and who, in adorning their homes, have duly planted of it, have doubtless been sorely vexed at seeing their favorites gradually overspread with what is by some called the "white malady." This malady is an affection of the leaves, and though not many are aware of its true nature, they readily perceive that the unfortunate trees wear an unnaturally yellow, or brown, and sickly aspect, and in some cases, after languishing a few years, die outright.

The leaves of such trees present the appearance of figure 35, *a*, being covered with innumerable elongate white bodies, and looking very much as though finely and profusely sprinkled with molten wax or paraffine. Careful examination will show these bodies to be the scales of the insect in question, and though when few in number they are mostly found in the groove of the leaf, which partially screens them, yet when abundant they cover the more salient sides, and give the tree a whitened look. I have never found this insect in injurious abundance, except on young trees; and according to Dr. Fitch, it is never met with upon the trees growing wild in our forests. It has proved quite troublesome to the young trees around St. Louis, and especially along the line of the Missouri Pacific Railroad. It was

described * by Dr. Fitch,† who had but an imperfect knowledge of it, and mistook the scale for the relic of the body of the dead female, and the true relic of said body for the remains of viscera; the three parts of the scale seemed to him to represent the head, thorax, and abdomen, while the male scales were supposed to be but half grown. In 1870 the male louse was simultaneously discovered by Dr. LeBaron and myself, and the first comprehensive account of the species appeared in the former's first report (pp. 83–96).

ITS NATURAL HISTORY

Is briefly told. The eggs, which may always be found under the new and healthy female scales during the winter, to the number of from fifteen to thirty, instead of from thirty to a hundred, as in the Oyster-shell species, are scarcely 0.01 inch in length, perfectly oval, and of a blood-red or brown-red color. The young larvæ usually commence hatching and leaving the scales about the first of May, though I have known them to do so as early as the 25th of April. They are of the same blood-red color as the egg, but have, otherwise, essentially the same form and structure as *pomicorticis*, though the head appears rather more squarely cut off between the antennæ, and is sometimes even a little sunken. The joints of the antennæ are irregular and not easily distinguished, but I have discerned seven, the terminal one ending in a long hair, and having two lateral hairs, the middle joint also having quite constantly two lateral hairs. The claw of the tarsi is imperfect and clumsy, and the two upper knobbed hairs or *digituli* are much longer than the lower ones.

The earliest hatched are, for the most part, males. They travel but little, and remain on the old leaves. Indeed, they often become attached under the tented protection of the mother scale. Soon after fastening, the skin becomes yellowish, and, with the exception of the antennæ, all trace of members is lost to the unassisted eye; a ridge forms down the middle of the back, and a dusky spot each side of it may always be noticed anteriorly. After the retreat of the insect, this scale is delicate, semi-transparent and amber-colored. The anal shield is pure white, straight, widening slightly behind, where it is either cut off squarely or ends in a slight lobe or an obtuse angle; the posterior border is somtimes ridged, and a distinct longitudinal ridge always runs along the middle. The average length of the male scale is 0.035, and it is fully formed in about ten days from hatching (Fig. 35, *b*).

* Signoret informs me, after examining specimens sent to him, that it is probably the *pini* of Hartig, described in 1839 in the *Jahresberichte ueber die Fortschritte der Forstwissenschaft* for that year. Not having access to the work, I am unable to decide the point; but I know that a very similar, if not identical, species occurs on the cultivated pines in England, as I have seen it on some trees in Mr. W. C. Hewitson's beautiful grounds, at Weighbridge.

† N. Y. Reps. Vol. I, p. 256.

The male louse (Fig. 36) may be seen by the well-trained eye, crawling over the needles and branches, and he may be found before the anal shield of any of the females begins to form. He has the same size and structure as his apple tree kinsman, and differs principally in being of a uniform orange-red.

[Fig. 36.]

The female scale averages 0.10 in length, and is completed in about three weeks; the median part is a little darker than the larval, and the anal shield has an even, white surface. It differs materially in form, according to the kind of pine it inhabits, being broader and more curved on the broader-leaved species, (Fig. 35, *d*), but usually narrow, and with a very slight curve on one side, on the White Pine (Fig. 35, *c*). The female herself presents very much the same appearance as figure 32, *d*, except in being red. The form is more lengthened, and there are not the strong bristles on the lobes of the abdominal joints. The margin of the anal plate is, also, less deeply notched, and the tubular secretors near it form a more regular row. The minute circular secretors are compact, the median set composed of 7–10, the upper laterals of 12–20, and the lower laterals of 14–18—the upper and lower laterals sometimes blending.

The newly-hatched female lice are instinctively prompted to migrate to the terminal and more permanent foliage, so as not to be borne to the ground themselves, or permit their eggs to be so carried to destruction, on the more basal leaves; while, as we have seen, the shorter-lived males, which are soon destined to become active again, fix themselves indifferently on the older foliage. The same end is attained on the part of the female as in the case of the Oyster-shell species, though a converse action is required in its attainment.

TWO-BROODED.

The Pine-leaf Scale-insect produces at least two broods each year, even in the more northern regions, where the Oyster-shell Bark-louse is single-brooded. Furthermore, the hatching is much more irregular than in the last-named species, so that it is difficult, if not impossible, to establish any definite period which shall separate the two broods. Neither am I sure that there are not more than two annual broods in the latitude of St. Louis; at all events, during the fore part of July the insect may be found in every stage of development, from the newly fixed larva to the full-formed and egg-covering female scale;

while as late as the first of October, females may be found which have not yet deposited; and even in the winter time many dried bodies are discovered, more or less completely filled with eggs, and indicating that they were overtaken by frost and killed before having accomplished the great end of their life.

CONFINED TO THE PINES PROPER.

From observations extending over several years, I conclude that this scale flourishes on trees belonging to the genus *Pinus* only, as I have never found it on the allied spruces or firs, or on any trees belonging to the other genera of the Pine family. The Red Pine (*P. resinosa*), the Bhotan Pine (*P. excelsa*), and the Yellow Pine (*P. mitis*), are affected almost as badly as the White Pine; while the Cembra Pine (*P. cembra*) I have found, in two instances, still more susceptible to it. It occurs only sparsely on the Pyrenaian Pine (*P. pyrenaica*) and the Corsican Pine (*P. laricio*); while on the Scotch Pine (*P. sylvestris*), the Austrian Pine (*P. austriaca*), and the *P. pumilio*, it likewise occurs sparsely, and the scales are broader.

NATURAL ENEMIES.

There is no evidence that mites attack this species as they do the preceding, but the smooth holes made by a little Chalcid which has not yet been bred, but which is either the *Aphelinus mytilaspidis* LeB., or a closely allied species, may frequently be noticed in the scales. The larvæ of certain small ladybirds belonging to the genus *Scymnus*, with their dense and even clothing of white cottony tufts,* feed alike on the Bark-lice and upon a woolly Aphid (*Chermes pinicorticis*, Fitch) which ofttimes covers the bark, and is frequently found in conjunction with the leaf-scale.

Certain unbred Lace-wing flies (*Chrysopa*) are also quite common, and their white, spherical, silken cocoons (see Rep. 1, Fig. 20, *c*), which are fastened to the twigs, should never be destroyed.

The Twice-stabbed Ladybird (*Chilocorus bivulnerus* Muls., Rep. 1, Fig. 4) may frequently be found crawling over the scale-infested trees, and is most efficient in checking the increase of the Coccids. Both the beetle and its gray and prickly larvæ feast upon the lice, and require great numbers of such minute animals to appease their appetites. I have often colonized a dozen or more larvæ on to a badly affected young tree, and the rapidity with which they clear such a tree is both interesting and satisfactory. I have previously shown how these prickly larvæ gather together and attach themselves in clusters when about to assume the pupa state, and how the pupa remains pro-

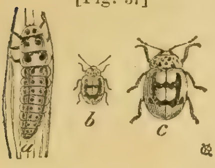
*I have bred *Scymnus consobrinus* Lec., and *S. cervicalis* Muls., from larvæ thus found, and Dr. Shimer has found *S. terminatus* Say, under similar conditions (Trans. Am. Ent. Soc. II, p. 385). A somewhat larger but similar larva found upon infested trees produces, as I have some reason to believe, the *Hyperaspis normata*, Say.

tected by the larval skin, which merely splits on the back and is loosened from the inclosed body, instead of being entirely worked off behind, as is the normal fashion with insects. On apple-trees, they usually crowd together on the rougher portions of the trunk, where the general similarity in color to the surroundings renders them sufficiently inconspicuous; but on the pines, they more frequently congregate around the ends of the twigs, which then appear as if covered with prickly burs, reminding one strongly, as Dr. Fitch well observes, of the ripened spikes of the Hounds-tongue (*Cynoglossum officinale*), and presenting a decided *nole-me-tangere* aspect.

The manner in which this memberless pupa shrinks and separates from the armed and membered larval skin furnishes a good illustration of that in which the larval scale of the Bark-louse itself is formed; and, were the skin ruptured below and behind instead of above and before, and strengthened by a secretion from the retreating body, the analogy would be perfect. As I have found the full-grown larva as early as the first of April, there is every reason to believe that the Twice-stabbed Ladybird hibernates both as larva and beetle.

Still another insect of this family, namely, the Painted Ladybird (*Coccinella picta* Randall), I have discovered preying on our Pine-leaf scale, as well as on the afore-named *Chermes*. The beetle (Fig. 37 *c*, enlarged; *b*, natural size) is of a pale clay-yellow or straw color, marked with black as in the figure; and its dusky-brown and pale-yellow larva (Fig. 37, *a*) has never before been connected with it or described. Hence I subjoin the following description:

[Fig. 37]



COCCINELLA PICTA Randall.—*Larva*—Form normal, rather stout, 0.36 inch long when full grown; 12 joints, exclusive of head. Color dark sooty-brown, with a medio-dorsal pale yellow stripe, narrowing at each extremity, broadening posteriorly on thoracic joints, and brightest on joint 3; a similarly pale lateral stripe. The ordinary tubercles—4 dorsal rows on abdominal joints, the two each side coalescing on the thoracic joints—polished black, with short bristle-stubs. Described from 3 specimens. *Pupa*—naked and suspended. No description taken.

It is not so numerous as the Twice-stabbed Ladybird, which is, perhaps, to be accounted for by the fact that its helpless pupa is not protected by any such mimic *chevaux-de-frise*.

REMEDIES.

Few trees suffer more from the loss of their leaves during summer than do the pines. Mr. Thos. Meehan, though not supported by many other botanists, considers that, physiologically, they are not true leaves, but half leaf, half branchlet; and, however much truth there may be in such a view, it is certain that they can not be replaced by new ones, as true leaves often can. But I have experimentally

proved that, if done in the spring, just at the time or a little after the new year's growth commences, all the old leaves of *strobus* may be stripped with impunity. It stands to reason that with small trees which are affected with the Leaf-scale, and which admit of being thus stripped, this is one of the most efficient means of exterminating the lice. As an experiment, I thus stripped two young trees belonging to Mr. Wm. T. Essex, of Kirkwood, and prevented the lice from extending to the newer growth. In this manner the trees recuperated, though so near unto death at the time that Mr. E. was quite willing to risk the operation. By the second year they presented a healthy and clean appearance. This remedy, where it can be employed, has the advantage of being thorough, and of enabling us to save the natural enemies, just enumerated, from the destruction which awaits the lice.

The White Pine holds its leaves a little over two years on older trees—somewhat longer on younger ones; but as on badly infested trees the old leaves are already well-nigh exhausted, their loss is not so much felt. Moreover, the lowermost branches are always most thickly covered with the lice, and it will often happen that the top of the tree will not need stripping. I have already stated that large trees on which this remedy would be impracticable do not suffer from the scale to the same extent as do smaller ones; so that where the remedy is most needed it can be applied. Care must be had to collect and burn all the detached leaves, and the operation should only be performed after the new growth of leaves has commenced, but *before* any of the female lice have settled thereon.

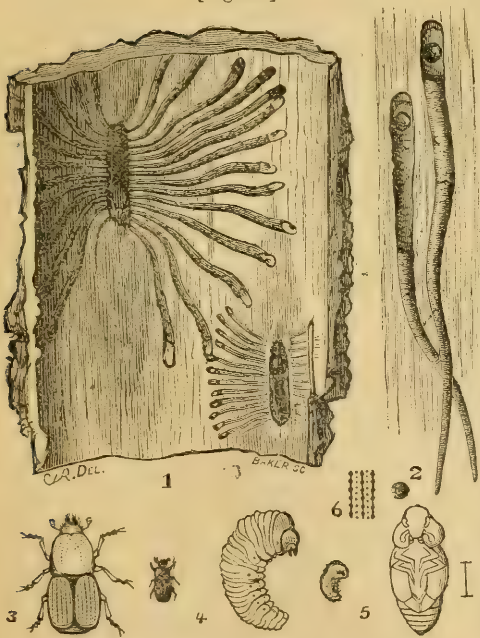
Powdered or liquid applications, intended to kill the young lice, are of little use, because, as we have seen, the latter do not all hatch out within a few days, as with the Oyster-shell species; but so irregularly as to necessitate continued applications throughout the greater part of the growing season, if intended to reach them all while young and unprotected by scales. For this reason, applications, to be of any value, must be of such a nature as to allow of being dusted or syringed over the trees; and must also have some caustic or penetrating properties, so as to destroy life under the scales, and reach these last in the protective groove in which they more generally dwell. I have tried carbolic soap with not very satisfactory results, except where it was used strong enough to kill all the leaves; and one tree thus treated, when the new growth was starting, recovered, and was freed of lice, but was evidently injured more than those which had been stripped, as I was for some time in doubt whether it would live or not. Dr. LeBaron has made applications of common fish brine, diluted at the rate of one pint to two gallons of water, or made twice as strong; also strong soap-suds, and unleached ashes dusted onto the trees when moist; but while none of them materially injured the trees, they none of them entirely exterminated the lice. Oily solutions, as with the Oyster-shell species, would doubtless prove most effectual here,

and those who have trees badly troubled with this "white malady," and can afford to risk destruction of them, should experiment in this direction. My friend, M. L. Dunlap, of Champaign, Ills., who had certain trees in front of his house which were once badly attacked, assured me that he had saved and cleared them by repeated syringing with cold water; but I am much inclined to think that natural agencies played a more important part than the cold water in producing the result.

THE HICKORY BARK-BORER — *Scolytus Caryæ* Riley.

(Ord. COLEOPTERA, Fam. SCOLYTIDÆ.)

[Fig. 38.]



Last summer I received the following descriptive letter:

DEAR SIR: I inclose you to-day, in a newspaper, a section of bark of shell-bark hickory. Tree stood in a cornfield on this "Chouteau Claim;" was deadened, and large portions of the bark came off, revealing the whole body of the tree covered with marks engraved in the hard wood—fac-similes of the marks on inclosed bark—and making the tree look as if flowers were photographed all over it, but flowers all of one kind. I found in some of the channels in the bark a black bug, which, I suppose, did this regular work. There was invariably, as far as I could observe, a hole through the bark, at the base of each of the longitudinal channels leading to the cross-channel. We removed large sections of bark already quite loose, and the entire inside was covered like the piece I send. I propose to have the tree cut down, and to preserve sections of it.

Yours, truly,

N. W. BLISS.

KINGSTON FURNACE, WASHINGTON CO., *July* 2, 1872.

The insect referred to by Mr. Bliss is the Hickory Bark-borer, first described from the female only, under the name of *Scolytus caryæ*,

in the *Prairie Farmer* of February 2d, 1867. I first became acquainted with the injurious nature of this beetle, through Mr. Arthur Bryant, of Princeton, Illinois, and the case of Mr. Bliss is the first on record of its doing damage in Missouri. The following passages from a letter received in 1867, from Mr. Bryant, convey an idea of the loss the insect has occasioned him, and contain some facts regarding its mode of working:

> I send you, by express, some pieces of wood and bark containing a worm which has for some years been destroying the hickory-trees on my farm. The trees grow on a strip of rich soil, striking the prairie on the east side of the forest, bordering the Bureau River. When I settled here, thirty-three years since, this tract was covered with bushes, with a few scattered trees, and was annually ravaged by fire. Since then a tall, dense growth of thrifty young timber, mostly bitter-nut hickory, (*Carya amara*), has grown up. The insect commenced its ravages about ten years since, and has killed many hundreds of fine young trees. It has sadly thinned my beautiful grove, and bids fair to destroy all the hickory trees in it. It is found in other localities in this vicinity.
>
> I first detected the insect in its winged form in September, 1855. Noticing some small holes, newly bored, in the smooth bark of a hickory-tree, I found, on examination, in each hole a small black beetle, which subsequent investigation satisfied me was the parent of the mischief. The mode of operation appears to be as follows: Boring through the bark, the insect forms a vertical chamber next to the wood, from half an inch to an inch in length, on each side of which it deposits its eggs, varying in number from twenty to forty or fifty in all. The larvæ, when hatched, feed on the inner bark, each one following a separate track, which is marked distinctly on the wood. Some trees contain them in such numbers that the bark is almost entirely separated from the wood. In many cases the upper part of the tree is killed a year or two before the lower part is attacked.

The insect has continued its ravages, and doubtless will do so until Mr. Bryant's entire grove is destroyed.

Through the kindness of Mr. Bryant I have, since 1867, been able to fully study the habits of the species.

There is, in Europe, a very closely allied beetle (*Scolytus destructor*) known to attack the Elm. It was for a long time a contested question as to whether this insect ever attacked healthy trees, and there were not wanting men of repute who considered it the effect rather than the cause of disease.* But Mr. Spence long ago discovered that though the female is probably seldom guilty of depositing her eggs in healthy, vigorous trees, both she and the male bore into such trees for food, thereby causing an unhealthy state of the tree, by which it is rendered an agreeable nidus for the insect. The habits of our Hickory *Scolytus* are similar to those of the Elm; but while, according to the best authority, the vertical channels formed by the

* See Westwood, in *Gardeners' Magazine*, (Eng.), Vol. XIV, p. 363.

female of *S. destructor* are generally about two inches long, those of *S. caryæ* are seldom more than one inch.

The natural history of the Hickory Bark-borer may be thus summed up:

It seems not to be very particular about the kind of hickory it attacks, as, besides the Bitter-nut and Shell-bark, (*alba*), there is good evidence that it affects the Pecan,* (*olivæformis*); and Dr. A. H. Barber, of Lancaster, Wisconsin, has favored me with specimens, and an account of its injuries to the Pig-nut Hickory (*porcina*). The beetles issue the latter part of June and fore part of July. Both sexes bore into the tree—the male for food, and the female mostly for the purpose of laying her eggs. In thus entering the tree, they bore slantingly and upward, and do not confine themselves to the trunk, but penetrate the small branches and even the twigs. The entrance to the twig is usually made at the axil of a bud or leaf, and the channel often causes the leaf to wither and drop, or the twig to die or break off.

The female, in depositing, confines herself to the trunk or larger limbs, placing her eggs each side of a vertical chamber, as described by Mr. Bryant. Here she frequently dies, and her remains may be found long after her progeny have commenced working. The larvæ bore their cylindrical channels, at first, transversely and diverging, (Fig. 38, *1*), but afterward lengthwise along the bark (*2*)—always crowding the widening burrows with their powdery excrement, which is of the same color as the bark. The full-grown larva (Fig. 38, *4*, natural size and enlarged) is soft, yollowish and without trace of legs. The head is slightly darker, with brown jaws, and the stigmata so pale that they are with difficulty discerned. It remains torpid in the winter, and transforms to the pupa state about the end of the following May. The pupa (Fig. 38, *5*) is smooth and unarmed, and shows no sexual differences. The perfect beetle issues through a hole made direct from the sap-wood, and a badly infested tree looks as though it had been peppered with No. 8 shot. The sexes differ widely from each other, the male having spines on the truncated portion of the abdomen, not possessed by the female. The eggs are deposited during the months of August and September, and the transformations are effected within one year, as no larvæ will be found remaining in the tree the latter part of July.

† See *Prairie Farmer*, August 10th, 1872, where Mr. Smiley Shepherd, of Hennepin, Ills., writes: "I have inclosed for your inspection a few specimens of a small beetle, found boring into the present year's growth of the Pecan-hickory. I also send you a package of the spray, that you may see the evidence of depredations in former seasons. This is the fourth year since they were noticed on my trees. The injury done is greater each year than the preceding. The trees can not survive such treatment more than one or two years more. They have been planted about thirty years, and were about fruiting."

These beetles are referred, by Dr. LeBaron, to *Scolytus muticus*, Say, and *S. 4-spinosus*, Say; but, as I have since learned, they were ♀ ♂ of *caryæ*.

I have always found associated with this bark-borer another larger borer, (*Saperda discoidea* Fabr.), an insect in which the two sexes differ so remarkably, both in size and coloration, that the male was subsequently described as *fuscipes* by Say, and whose larva, before maturing, penetrates the solid wood.

NATURAL ENEMIES.

I have bred two interesting parasites from this *Scolytus*. They both belong to the same subfamily (*Braconides*) of the Ichneumon-flies as the two parasites of the Plum Curculio, (3d Rep., pp. 24–28), and according to the eminent Hymenopterist, Mr. E. T. Cresson, to whom I am under obligations for so many favors, they are both undescribed. Their larvæ, after killing the bark-borers, form little pale cocoons in which to undergo their transformations. The first may be called the Three-banded Spathius. The genus was characterized by Esenbeck, who believed that the insects composing it deposited their eggs in the larvæ of leaf-eating beetles.

Spathius trifasciatus, N. Sp.—♀. Average length, 0.18 inch. Color, light-brown. *Head* pubescent, palpi long and pale; eyes black; ocelli black, contiguous; antennæ smooth, pale, and reaching to second abdominal joint. *Thorax* with sutures dark-brown; legs more or less dusky, the tarsi (except at tip) an annulus at base of tibiæ, and the trochanters, pale; wings fuliginous, with a white fascia at base, at tip and across outer middle of front wing, including the inner half of stigma, the outer half of which is dark-brown; middle fascia most clearly defined. *Abdomen* slightly pubescent at sides and tip; first joint pale, petiolate, and with short and longitudinal aciculations above; second joint pale above, the others more or less brown; ovipositor pale, dusky at tip, and as long as abdomen.

One bred specimen.

♂—Differs in being much darker colored, the head, thorax and femora being brown and the metathorax and base of first abdominal joint black.

One bred specimen.

The second is a fly of about the same size, and belongs to the genus *Bracon*. Mr. Cresson has described it in MS., and I append his description:

Bracon scolytivorus, Cress.—♀—Black, shining, metathorax and base of abdomen pubescent; face, anterior orbits, lower half of cheeks, clypeus, mandibles, except tips, palpi, tegulæ, legs, including coxæ, and abdomen, honey-yellow, the latter darker; posterior coxæ sometimes dusky; antennæ at base beneath, dull testaceous; wings fuliginous, apical half paler, iridescent; abdomen shining, first segment whitish laterally, the base and disc sometimes dusky; base of second segment with a large subtriangular flattened space inclosed by a deep groove, the posterior side of which is generally blackish; ovipositor longer than abdomen; sheaths black; length, .15—.17 inch.

♂—More pubescent; posterior coxæ blackish, also the femora above, especially the posterior pair; posterior tibiæ dusky; abdomen black, polished; apex of first, basal half of second and sides of apical segments more or less honey-yellow; sides of basal segment whitish; wings paler; abdomen narrower and rather more convex; length, .16 inch.

Three ♂, three ♀ specimens.

REMEDIES.

As to any remedy, though practical men, especially those owning fine hickory groves, will naturally look for one, they can, in this respect, not be satisfied; for if, after so many years' experience, Mr. Bryant can not think of any practical cure, it would be folly in others to speculate. The habits of the insect defy our efforts in this regard; and though in Europe coal tar brushed on the trees has been found effectual in keeping the Elm *Scolytus* away, the idea is of little value, since the tops of the trees are first attacked, and, in a large grove, the roughness of the lower bark often renders a close inspection necessary to detect the first holes made.

The only hope I entertain is from the little parasites above referred to; for when nature comes to man's aid, in the shape of parasitic insects, the vegetable feeders often have to succumb. If, therefore, upon careful examination, the white cocoons of this parasite are found abundantly in the bark of the infested tree, I should advise Mr. Bliss to let other trees in the neighborhood remain. But if no such parasites are found, the only way to prevent the spread of the *Scolytus* is to cut down *and burn or scorch* all infested trees.

SCOLYTUS CARYÆ Riley—*Larva*—showing no characters of specific value.

Pupa—perfectly glabrous, the pygidium truncate.

Imago—length, 0.15–0.20 inch. Color, either entirely black, or black with brown elytra.

♂—Head above flat, concave toward tip and coarsely aciculate, coronated with long incurved dull-yellowish hairs around the margin; labium also quite hairy; antennæ pale rufous. Thorax very little longer than wide, and very little narrowing in front; sub-obsoletely punctate above, but more distinctly so at sides. Elytra with about 10 striæ, confused at sides but regular above, and composed of small, deep, approximate punctures, bearing (not always) a few short hairs; interstitial spaces with a single row of minute and sub-obsolete punctures; tip more rugosely punctured and pubescent; venter opaque, densely punctate at tip, less so at base; the first joint emarginate and produced in the middle into a blunt spine; the second as long as the others together, strongly excavated, with the hind margin carinate and slightly spined at sides, and with a longitudinal carina dividing it into two concavities; third with the hind margin also carinate, and bearing three more or less prominent conic-acute spines; fourth also carinate with a smaller spine in the middle; fifth, pubescent.

♀—Differs in having the head rather shorter, more rounded, less aciculate and less hairy; the thorax perhaps a little more narrow in front; the elytra with the interstitial spaces rather more distinctly punctured, and the venter unarmed.

Described from 50 bred specimens of each sex.

The ♂ closely resembles *S. 4-spinosus*, Say, (Am. Ent. I, p. 182,) but differs from the description of that species in not having the tips of the elytra denticulate, in having the venter punctate, and in the projection on the first and longitudinal carina on the second ventral joints. It is just barely possible that the ♂ of *caryæ* ♀ is the insect intended by Say in his description of *4-spinosus*, in which event *caryæ* sinks. But if such prove to be the case, he either described from an aberrant individual, or neglected to mention important characters, as none of the differences mentioned are obsolete in the many specimens of *caryæ* which I have examined. The question can only be settled by comparison with his types, if such exist. I leave it with the specialist, and shall

abide by his decision. Under the circumstances, without typical specimens, we should have most right to conclude that the two are distinct, and should be slow to charge faults of omission, where such prominent and constant characters are concerned. *S. 4-spinosus* Say may prove to be ♂ of *muticus* Say. This uncertainty as to the species intended by some of the old and honored authors, who did not understand, as we do, the variation to which species are subject, is constantly confronting the entomologist, and should teach him the importance of mentioning the number of specimens from which a description is drawn up.

The ♀ might be referred to *muticus* Say, as described in the same work, but is easily distinguished by LeConte's subsidiary diagnosis. (Trans. Am. Ent. Soc. II, p. 167.)

THE ROSE CHAFER—*Macrodactylus subspinosus* (Fabr.).

(Ord. Coleoptera, Fam. Melolonthidæ.)

[Fig. 39.]

In the summer of 1872, this beetle was unprecedentedly abundant in some parts of Missouri, and more especially to the west of us, in Kansas. I reproduce, therefore, in the main, an article written for the Transactions of the Kansas State Board of Agriculture.

Dear Sir—Having been appointed by our State Horticultural Society (at the meeting held at Humboldt this week) to conduct correspondence with you relative to an insect that troubles us greatly, which we are unable to name correctly, I send you samples and description of the work done by it.

The extent of country over which it does damage enough to make it noticeable is, as far as I can learn, confined to only two or three counties—Allen, Woodson, Linn and Bourbon. It has only been some three years since it appeared to be so troublesome as to call the attention of persons of common observation. Last year (1871), my first year in Kansas, I noticed it in the grape bloom, but not in destructive numbers. It reappeared May 25th this year, and began eating the grape bloom, and, where very numerous, even the foliage. I have seen vines entirely stripped of leaves, except the net-work. They do not trouble the fruit after it is as large as shot (No. 1). Whole trees, and I am told, whole orchards of peaches are eaten up—only the fruit. Several beetles stay on one peach until it is gone before going to another.

I have seen small three-year-old cherry trees stripped of leaves and the fruit eaten entirely up too. They are about gone now; three weeks will suffice them, I guess. We know of no remedy except hand-picking, but some who have only a few grapes to watch catch them in a basin of water into which they easily drop when disturbed, and so save their crop. The beetle devours the bloom of the blackberry and sometimes the young fruit. I can't find a correct description of it in your reports published by the State of Missouri. *Colaspis flavida* comes the nearest. But the description of the "Grape Fidia," in Bush's catalogue, comes nearer, according to my observa-

tion. One man reported at the meeting of having seen it fourteen years ago in Linn county, first on wild persimmon blossoms and then on his grapes. But he caught them, and has been troubled but little. Please return a description, etc., etc., for our benefit and instruction.

Yours respectfully,

H. E. VAN DEMAN.

GENEVA, ALLEN COUNTY, KANSAS.

This insect is named in the heading, and illustrated at figure 39. It is one of those species whose larva develops under ground, and can not be very well dealt with in this stage of its life. We must contend with it in the beetle form, and there is no other effectual means than by hand-picking, or by shaking into vessels and on to sheets. This work can be greatly facilitated by taking advantage of the insect's tastes and preferences. There is conclusive testimony that it shows a great predilection for the Clinton, and its close allies, of all other varieties of the Grape-vine, and that it will gather upon that variety and leave others unmolested, where it has a chance. Those who are troubled with this beetle will no doubt take the hint. No better account of its natural history has ever been written than that by Harris in his work on "Injurious Insects," and I quote some of the more important paragraphs:

"The natural history of the Rose Chafer, one of the greatest scourges with which our gardens and nurseries have been afflicted, was for a long time involved in mystery, but is at last fully cleared up. The prevalence of this insect on the rose, and its annual appearance coinciding with the blossoming of that flower, have gained for it the popular name by which it is here known. For some time after it was first noticed, rose-bugs appeared to be confined to their favorite, the blossoms of the rose; but within forty years they have prodigiously increased in number, have attacked at random various kinds of plants in swarms, and have become notorious for their extensive and deplorable ravages. The grape vine in particular, the cherry, plum and apple trees have annually suffered by their depredations; many other fruit trees and shrubs, garden vegetables and corn, and even the trees of the forest and grass of the fields, have been laid under contribution by these indiscriminate feeders, by whom leaves, flowers and fruits are alike consumed. The unexpected arrival of these insects in swarms at the first coming, and their sudden disappearance at the close of their career, are remarkable facts in their history. They come forth from the ground during the second week in June, or about the time of the blossoming of the damask rose, and remain from thirty to forty days. At the end of this period, the males become exhausted, fall to the ground and perish, while the females enter the earth, lay their eggs, return to the surface, and, after lingering a few days, die also.

"The eggs laid by each female are about thirty in number, and are deposited from one to four inches beneath the surface of the soil; they are nearly globular, whitish, and are about one-thirtieth of an inch in diameter, and are hatched twenty days after they are laid. The young larvæ begin to feed on such tender roots as are within their reach. Like other grubs of the Scarabæians, they lie upon the side, with the body curved so that the head and tail are nearly in contact; they move with difficulty on a level surface, and are continually falling over on one side or the other. They attain their full size in autumn, being then nearly three-quarters of an inch long and about an eighth of an inch in diameter. They are of a yellowish-white color, with a tinge of blue toward the hinder extremity, which is thick and obtuse or rounded; a few short hairs are scattered on the surface of the body; there are six short legs, namely, a pair to each of the first three rings behind the head; and the latter is covered with a horny shell of a pale rust color. In October, they descend below the reach of frost, and pass the winter in a torpid state. In the spring, they approach toward the surface, and each one forms for itself a little cell of an oval shape, by turning around a great many times, so as to compress the earth and render the inside of the cavity hard and smooth. Within this cell the grub is transformed to a pupa during the month of May, by casting off its skin, which is pushed downward in folds from the head to the tail. The pupa has somewhat the form of the perfect beetle, but it is of a yellowish-white color, and its short, stump-like wings, its antennæ and its legs are folded upon the breast, and its whole body is inclosed in a thin film that wraps each part separately. During the month of June, this thin, filmy skin is rent, the included beetle withdraws from its body and its limbs, bursts open its earthen cell, and digs its way to the surface of the ground. Thus the various changes from the egg to the full development of the perfected beetle are completed within the space of one year.

"Such being the metamorphoses and habits of these insects, it is evident that we can not attack them in the egg, the grub or the pupa state; the enemy in these stages is beyond our reach, and is subject to the control only of the natural but unknown means appointed by the Author of Nature to keep the insect tribes in check. When they have issued from their subterranean retreats, and have congregated upon our vines, trees and other vegetable productions, in the complete enjoyment of their propensities, we must unite our efforts to seize and crush the invaders. They must indeed be crushed, scalded or burned to deprive them of life; for they are not affected by any of the applications usually found destructive to other insects. Experience has proved the utility of gathering them by hand, or of shaking them or brushing them from the plants into tin vessels containing a little water. They should be collected daily during the period of their visitation, and should be committed to the flames or killed by scalding water."

THE FALSE CHINCH-BUG — *Nysius destructor*, N. Sp.

(Subord. HETEROPTERA, Fam. LYGÆIDÆ).

A NEW ENEMY TO THE GRAPE-VINE, POTATO, CABBAGE, AND MANY CRUCIFEROUS PLANTS.

By calling this a *new* enemy, I do not wish to be understood to intimate that it never existed before. It has, in all probability, been in existence as long as its more injurious, genuine name-sake; but I call it new because it has heretofore been unknown as an injurious insect, and because, further, it has not even been described by entomologists, though I have had it in my cabinet for some years.*

[Fig. 40.]

The first time I heard of the injuries of this insect was in the fore part of last May, when I learned that young Delaware vines, belonging to Dr. James D. Davis, of Clarksville, Missouri, were being much injured by them, and that they were so numerous that the ground was literally covered with them. From many specimens received, they all at that season proved to be in the immature stages. Subsequently I received the following letters, which refer to the same species:

DEAR SIR — Dr. Bell, living four miles from this city, sends in the inclosed insects, which he says are destroying his potatoes. He wishes to know what they are, and if you can suggest any way of driving them off or protecting his crops against them. Will you be so kind as to write me? I send specimen of leaf showing injuries.

Yours, truly, W. B. STONE.

KANSAS CITY, MISSOURI, June 15, 1872.

DEAR SIR — Many of our market gardeners are complaining of the ravages of a certain insect of the order Hemiptera, of which I send specimens in box by mail with this note. The pest in localities occurs in great numbers, injuring the foliage of turnips, beets, radishes and cabbages. Can you tell me the name, and refer me to some account of this bug?

Thanks for your prompt reply to my inquiry concerning the White Grub Sprout.

Hoping soon to hear from you, I remain most sincerely yours,

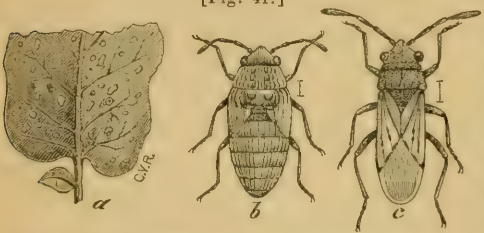
F. H. SNOW.

STATE UNIVERSITY, LAWRENCE, KANSAS, June 24, 1872.

* Last summer I announced my intention to describe it in the *Western Planter* for June 29th, 1872; but Mr. Wm. R. Howard, of Forsyth, not having noticed the announcement, subsequently published in *Phillips' Southern Planter*, under the name of *Nysius raphanus*, a description which, considering the close resemblances the bug bears to other described species of *Nysius*, and the variation it is subject to, was somewhat insufficient, but which was afterward copied into the *Country Gentleman* (Sept. 15th, 1872), and the *Canadian Entomologist* (Nov. 1872). Upon communicating the facts to Mr. Howard, and for other good reasons, he expressed the desire to sink his own name in favor of that here employed.

Later in the season the mature bugs were forwarded to me from Taney county, Missouri, under the supposition that they were Chinch-bugs, and other accounts reached me from Kansas, of the ravages of a bug, generally called the Chinch-bug, but which was evidently the species in question. Several insects have, at different times, been mistaken for the Chinch-bug, and under the head of "Bogus Chinch-bugs," I have indicated some of them in my second Missouri Report, (p. 31). They are thus confounded with that arch-destroyer, more on account of the nauseous, bed-buggy odor which they have in common, than because of their close relationship or resemblance. The bug under consideration, however, not only has the same odor, but in size and general appearance bears a good deal of resemblance to its more notorious associate, and for that reason may be known by the vernacular name of False Chinch-bug. From the figure (Fig. 40) of the genuine Chinch-Bug, that insect will be seen to have a decidedly black

[Fig. 41.]



head and thorax, with two conspicuous black spots on the front wings (*hemelytra*); while *Nysius destructor* (Fig. 41, *c*) is of a mcre uniform, paler, tarnished brown color. In habit the two insects differ materially; for while the former is the grain-grower's particular dread and terror, and confines its injuries almost entirely to cereals and grasses, the latter has not yet been found on cereals, and shows a predilection for plants of the Mustard family, though it attacks alike the Potato and even the Grape-vine.

In common with all other true Bugs, this insect feeds by suction; and the way in which it injures a plant is by depriving the same of its juices, and causing it to wilt. The potato leaves sent me by Mr. Stone presented the appearance of figure 41, *a*, showing little, rusty, circular specks where the beak had been inserted, and little, irregular holes, which looked more as if made by some Flea-beetle, one of which, the Cucumber Flea-beetle (*Haltica cucumeris* Harr.), is known to thus injure Potato leaves.

I can not now give you its complete natural history, as to do so will require further study of its habits, which I hope to be able to make before the close of the year. From analogy we may infer that there are two or three broods in the course of the year, and that, as in the case of the Chinch-Bug, it passes the winter in the perfect state, and is difficult to combat when once infesting the field or garden. Clean culture, and especially the burning of weeds and rubbish in the winter time, will doubtless prove to be the best guarantees against its injuries. The young bugs are without wings, and are of a paler color, with more or less distinct longitudinal dark lines on the head and thorax. The pupa (Fig. 41, *b*) has the front part of the body marked

with more distinct red and brown lines, with the abdomen paler, and with longitudinal pinkish mottlings. It is a variable species in all stages, and I submit below a full description for those interested:

NYSIUS DESTRUCTOR, N. Sp. (Fig. 41, *c*). General color grayish-brown; of shape of *N. thymi* Wolff. *Head* either minutely or more coarsely punctate, and more or less distinctly pubescent; the surface usually brown, with a distinct black, longitudinal line each side, broadening on the crown, but generally leaving the orbit of the eyes pale; these lines sometimes more diffuse and occupying the whole surface, except a median brown spot at base of crown, and a narrow, paler spot on the clypeus; ocelli piceous; eyes opaque, either black or slate-color; face sometimes uniformly pubescent and appearing dark grayish-brown; but more generally black each side of rostrum, with a distinct yellowish-brown spot on the cheeks below the eyes; rostrum piceous, paler at base and reaching to hind coxæ; antennæ either pale yellowish-brown or darker brown, the torulus and first joint darkest. *Thorax*, pronotum narrowing anteriorly, the sides slightly sinuate, irregularly and more coarsely punctate than the head, more or less pubescent, dingy yellow or brown, with a transverse black band near the anterior edge, obscuring the incision and leaving the edge pale, especially in the middle, where there is often a conspicuous pale spot; also five more or less distinct longitudinal dark lines, the central one most persistent and leading on the posterior margin to a pale, shiny, impunctate spot; the callus at hind angles, and sometimes an intermediate spot between it and the median one, and the entire posterior margin, also pale and impunctate; scutellum dark, coarsely punctate, sometimes with a smooth median longitudinal ridge ending in a pale spot, and with the lateral margins pale; prosternum dark, more or less pubescent, the anterior and posterior margins, and a band outside of coxæ, more or less broadly pale; mesosternum and metasternum also dark, with the pale spots outside of coxæ. *Legs* pale yellow, inclining more or less to brown; coxæ dark at base, pale at tip; trochanters pale; front and middle femora spotted more or less confluently on the outside with brown; hind femora, ♂ dark brown, except at tips and base; ♀ spotted only; tibiæ ringed with brown at base; tarsi marked more or less with brown, especially at tip. *Hemelytra* either colorless, transparent and prismatic, or distinctly tinged with dingy yellow; shallowly punctate and very finely pubescent, the veins of corium and clavus dingy yellow, with brown streaks, the more constant of these streaks being two on posterior margin of corium, and one at the tip of clavus. *Abdomen*, ♂ tergum piceous, with the sutures and the sides of some of the joints rarely paler; venter piceous, minutely and regularly covered with gray pubescence; ♀ sutures and spots on tergum more often pale; venter dingy yellow, except at base; ♀ paler than ♂, and generally larger. Average length 0.13 inch.

Larva—Dingy yellow, with more or less distinct longitudinal dark lines, especially on head.

Pupa (Fig. 19, *b*). Same color, with more distinct red and brown longitudinal lines, and two little tooth-like, pale yellow processes at inner base of hemelytra pads, indicating the wings; the abdomen paler than the rest of the body.

Described from numerous specimens. I have some, especially males, in which the black so predominates that the paler parts of the head and thorax are scarcely traceable, while in others again the pale parts predominate almost to the exclusion of the black. Indeed, so variable is the species that it is difficult to see wherein some of the specimens differ from the European *thymi*, or from *N. angustatus* Uhler, and it is barely possible that future comparison will show specific identity between some or all of the three. But as long as authors fail to give the variation a species is liable to, or the number of specimens a description is drawn up from, it will remain impossible to decide such questions satisfactorily, and I name *destructor* at the suggestion of our Hemipterist, Mr. P. R. Uhler, of Baltimore, who has examined specimens which I sent him.

[The above account of this new and injurious bug was sent, with other matter, on the first of July last, to Mr. Alfred Gray, Secretary of the Kansas State Board of Agriculture, for publication in the Transactions of said Board, where it appears. Since that time I have met with it everywhere in my travels in our own State and in Kansas. Besides the plants above enumerated, it proved in some instances troublesome to strawberry plants, to young apple grafts just as they were sprouting, and especially to turnips and beets. On all the more tender plants enumerated the bugs cluster just as does the genuine Chinch-bug, and cause the leaves to wilt by their suction. Late in the fall I found them very abundant, in all stages, collecting under purslane, and they doubtless make use of this spreading and close-fitting weed for winter quarters. At some of the fall meetings of the Meramec Horticultural Society, complaints were made of a new habit which the Chinch-bug had of injuring potato vines, and of crowding on the tubers and injuring them after they were dug. The False Chinch-bug was undoubtedly the insect observed.]

INSECTS INJURIOUS TO THE GRAPE-VINE.

THE GRAPE-VINE APPLE-GALL—*Vitis pomum* Walsh & Riley.

(Ord. DIPTERA, Fam. CECIDOMYIDÆ.)

[Fig. 42.]

Besides the leaf-gall caused by the Grape Phylloxera, the Grape-vine is subject to various other gall-growths or excrescences, the nature of which often puzzles the vine-grower. I shall give an account of four of the most conspicuous which are found in Missouri. They are all caused by Gall-gnats (*Cecidomyidæ*), the larvæ of which are distinguished by being very generally of an orange color; but more especially by having on the upper surface, near the head, a horny process known as a breast-bone.* This process is variable in shape, but more often clove-

*This process is said, by all authors with whom I am acquainted, including Baron Osten Sacken, to be ventral, for which reason, I suppose, it has been called the "breast-bone." I believe myself that it is dorsal. As, however, it sometimes has a good deal the form of the breast-bone, or "wish-bone," of a fowl, the term may be retained, though conveying a wrong idea. These larvæ are also said to differ from all other insect larvæ in having fourteen joints. I have examined a great number of Cecidomyidous larvæ without being able to make out any such abnormal number, while in many species it is difficult to detect more than twelve and a subjoint. Usually, I have been able to clearly make out thirteen joints and a subjoint, which is the normal number in insects.

shaped, Y-shaped, or oar-shaped. It always has a stem, which is mostly hidden, and terminates in two projections or prongs (sometimes three in those which are oar-shaped), which are armed with sharp points. It is retractile, and the prongs may be exerted at will, and are doubtless intended to assist in abrading the tissue of plants, so as to cause an abnormal flow of sap, which serves as food for the larva. That they have little, if anything, to do in causing the gall-growth, we may

[Fig. 43.]

infer from analogy, and from the fact that many Cecidomyidous galls are formed before the larva hatches, and depend on something deposited with the egg. The perfect flies are mostly of a dull black color, like that represented at figure 43, (*a* female; *b* antennæ of male,) and many species so closely resemble each other that it is next to impossible to distinguish them when dry. Those which produce the galls here mentioned are difficult to rear, and, with one exception, are not yet known.

The Grape-vine Apple-gall has been a fruitful source of speculation, and has given rise to some curious botanical theories, as the following extract will attest:

AN APPLE GROWING ON A GRAPE-VINE.

A Vegetable Phenomenon.—In the garden of Capt. David E. Moore, Lexington, Va., there is growing on a grape-vine, a fully developed apple. On one side of the apple is an appearance of what might have been a grape-bloom. This interesting *lusus naturæ* is, as far as we know, without precedent, and of course has attracted marked attention, and caused no little speculation in the circle learned in such matters about Lexington. The prevailing opinion, we learn, is that an apple-bloom falling accidentally upon a grape-bloom, became incorporated with it and produced the result; but, if so, is it not singular that such an accident had never occurred before? And, if so, again, does it not teach that the grape and apple may be grafted on each other? We hope the pomologists of Lexington will note very carefully all the phenomena of this freak of nature, and that they will have the apple photographed, with a portion of the vine, before its removal, for engraving and publication in Horticultural journals.

—[*Richmond Whig*.

When growing on vines in the vicinity of hickory trees, it has ridiculously been considered a hybrid fruit between these two very widely separated plants.

The form of the gall is variable—sometimes being quite flattened or depressed, but more often spherical, or flattened at base and more pointed at tip. When young it is downy on the outside, and succulent, with a pleasant, acidulous flavor. When mature, it usually has eight or nine longitudinal lobes, as in a musk-melon, and is smoother (Fig. 42, *a*). A transverse section (*b*) shows it to consist

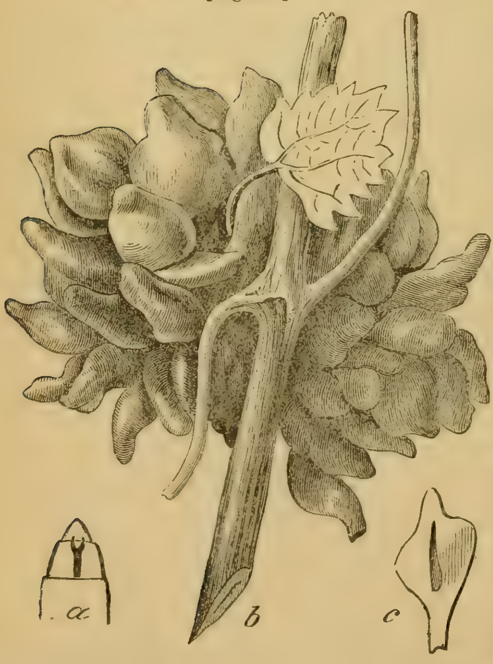
of a fleshy outside covering, like the hull of a walnut, and of a much harder, woody interior, with numerous longitudinal two-tiered cells or cavities, the upper tier twice as long and more regularly separated by harder fibre than the lower. The yellow larvæ are found in these cavities, and they have a brown, clove-shaped breast-bone. This gall, which bears so great a semblance to a fruit, doubtless carries the semblance still further by falling to the ground. And as the seed is released upon the death of the fruit which surrounded it, and consigned to the bosom of the great Mother Earth for development, so the larvæ escape from the decomposing and softening gall to consign themselves likewise to the same great Nursery, which seems to be absolutely necessary for their well-being and growth, as I have kept the galls for over a year out of Earth and away from her fecund influences without getting the perfect gnats.

This gall was first described in the *American Entomologist*, (Vol. 1, p. 106.)

THE GRAPE-VINE FILBERT-GALL—*Vitis coryloides* W. & R.

(Ord. DIPTERA, Fam. CECIDOMYIDÆ.)

[Fig. 44.]



This gall, (Fig. 44, *b*,) as its name implies, bears some resemblance to a large bunch of filberts or hazel-nuts. It is found more frequently than the preceding, and especially on the wild River Bank grape, (*Riparia*), in the month of July. It is an assemblage of separate galls, more or less coalescent, varying in number from 10 to 40 or more, and of different shapes, being either round, irregularly oval, fusiform or pyriform, but generally narrowing at tip. When young, these galls are densely pubescent or woolly on the outside, but less so when mature. The interior is fleshy, juicy, sub-acid; and a transverse section shows a single longitudinal cell in each (Fig. 44, *c*.) The gall is evidently a defor-

mation of a bud, as it springs from a single point where a bud would be, and often has quite a stem to it. A stunted, deformed leaf is also sometimes found upon it, as given in the figure.

The larva is orange-yellow, partly transparent, partly opaque, and has the breast-bone clove-shaped as in the preceding (Fig. 44, *a*), and doubtless leaves the gall and enters the ground to transform. First described in *Am. Entomologist* (I, p. 107.)

THE GRAPE-VINE TOMATO-GALL—*Vitis tomatos.*

MADE BY *Lasioptera vitis* O. S.

(Ord. DIPTERA, Fam. CECIDOMYIDÆ.)

The following clipping will show that this gall, which is quite common in the summer months on the River Bank grape and its cultivated varieties, has not remained unnoticed by the curious, and that it has, like the others, its fruit resemblances:

[Fig. 45.]

FREAK IN A VINEYARD.—In gathering grapes to-day we found one of the clusters, in shape, a *perfect tomato.* It is of quite large size, and on the outside is divided into eight segments or lobes, having a seed to correspond with each segment or lobe. It was found on a cluster of one of Rogers' Hybrids, and a peculiarity is, that the grape is *blue*, while this is *red.* In flesh and seeds and all else it is a perfect grape. President Wilder's Trophy tomato stands about three rods from the vine.

I call upon President Wilder to explain with what sort of propagating qualities he has invested his Trophy tomato, to know, if we continue the cultivation of that fruit, whether our apples, plums, cherries, etc., will or will not turn into Trophy tomatoes. I have saved the eight seeds for a further solution of the problem.

If President Wilder declines an explanation for *fear of the consequences*, I call upon all the horticulturists of America to commence at once an investigation, and I will furnish them with the *hide*, which I have carefully preserved as conclusive testimony against him.

R. L. DORR.

DANSVILLE, Livingston county, N. Y., *Oct.* 6, 1872.

[*Rural New Yorker.*

It is the most variable gall with which I am acquainted, as it may be found of all sorts of fantastic shapes, from the single, round, cranberry-like swelling on a tendril to the large collection of irregular bulbous swellings on the stem or leaf-stalk; sometimes looking not unlike a bunch of currants or a bunch of grapes, but more often like a collection of diminutive tomatoes, such as the Cluster Tomato, grown by Mr. J. C. Ingham, of St. Joseph, Michigan.* It was first briefly described, together with the fly which produces it, by Baron Osten Sacken (Diptera of N. A., part I, pp. 201–2). The substance of the gall is soft, juicy and translucent; the flavor pleasantly acid, and the color yellowish-green, with rosy cheeks, or else entirely red. Each swelling has several cells, (Fig. 45, *a*), in each of which is nursed an orange-yellow larva, which, upon the dissolution of the gall, enters the ground to transform, and emerges as a pale reddish gnat, with black head and antennæ and gray wings.

This gall-maker is subject to the attacks of at least two different enemies—one a species of *Thrips*, which invades the cell and destroys its inmate, and one a true Hymenopterous parasite, belonging apparently to the family *Proctotrupidæ*, and which, after killing the gall-maker, spins a cocoon within the cell.

THE GRAPE-LEAF TRUMPET-GALL—*Vitis viticola* O. S.

(Ord. DIPTERA, Fam. CECIDOMYIDÆ).

This is another, more regular, gall, made by a gall-gnat which has not yet been described. It is elongate, conical, and grows more or less numerously from the surface of the leaf, looking something like a small trumpet. I have found it on both wild *Cordifolia* and *Riparia*, and it doubtless occurs on their cultivated varieties. It is also found on *Labrusca* and *Vulpina* (see A. E. II, p. 28). The usual color is a bright crimson, but it sometimes inclines to green, especially when young, or on the under side of the leaf; for though it is more often

* Figured in *Prairie Farmer*, September 21, 1867.

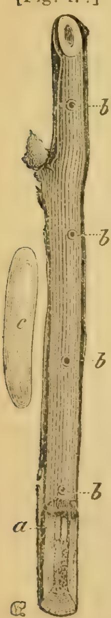
[Fig. 46.]

found on the upper side, I have met with it antiposed. Upon cutting into these galls we shall find them to be hollow, and each to contain a pale orange larva, which probably resembles those already mentioned in transforming under ground. The gall was first briefly described by Baron Osten Sacken (Diptera of N. A., part I, p. 202). Similar but distinct galls grow on the leaves of Hickory and Hackberry, but are always green.

EGGS IN AND ON CANES AND TWIGS.

Of the innumerable forms of insect-eggs which are met with on plants, the few herewith described are continually sent to me from correspondents who desire information as to their nature. Some of them were described by me in the *American Agriculturist* for last August, from which I shall draw largely in describing them again. The first (in all probability those of the Jumping Tree Cricket, *Orocharis saltator* Uhler) are represented at figure 47, and are so abundant this winter that they were received from six different quarters just as this report is going to press.

[Fig. 47.]



The punctures are one-third to half an inch apart, and appear as if made by a rather large-sized pin. The illustration is from a piece of grape cane. On Damson twigs sent by J. A. Franklin, of Bluffton, the parent insect has very generally gnawed off a portion of the tender bark before making a puncture—a proceeding not always followed when harder wood is used. Each of these punctures leads to from one to twelve slender, elongated eggs, (*c*), rather more than the tenth of an inch long, more or less opaque and whitish, but generally of the color and transparency of amber, except at the extreme head end, which lies toward the orifice, and which is always opaque and very finely granulated. The puncture is direct to the pith, in which the eggs are inserted lengthwise; and the number varies, according to the amount of pith in the twigs selected. About the first of May these eggs hatch out into little, dingy crickets; and though I have not

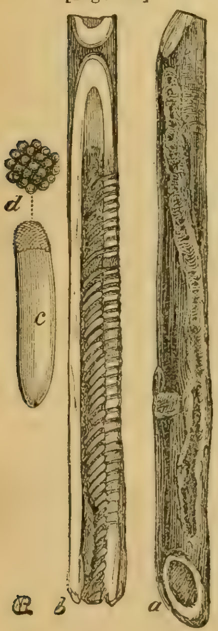
[Fig. 48.]

yet succeeded in bringing them through all their molts, and no one has bred the perfect insect, I have little doubt, from the larval characteristics, that they will prove to be the Jumping Tree Cricket mentioned.

This insect (Fig. 48, *a*, ♀; *b*, ♂) is of a pale yellowish-brown color, the female differing from the male in possessing a long ovipositor, and in her wings being more rounded and less ribbed and veined, so that she can not sing as he does.

The twigs or canes of various cultivated plants, and notably those of the Grape-vine, Apple, Peach, Raspberry, Blackberry, White willow and Soft maple, are often more or less split or disfigured by a series of closely set but irregular punctures, as illustrated at figure 49, *a*. Upon cutting into such twigs we find that, unlike the eggs we have already mentioned, these all lie diagonally across the pith, close together, in a single, irregular, longitudinal row, as at *b*—the irregularity sometimes making the row look as if double. More carefully examined with a lens, each egg appears pale yellowish, sub-elliptical, a little curved, more pointed at lower end (*c*), and capped at the head or more rounded end, with regulary arranged, white, opaque granulations, which, under a low-power microscope, appear as shown at *d*.

[Fig. 49.]



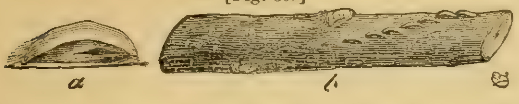
These are the eggs of the Snowy Tree-cricket (*Œcanthus niveus* Harr.), an insect briefly noticed in my first Report (p. 138). The young also hatch about the first of May. After eating through its egg-cap, the new-born cricket is still enveloped in an exceedingly fine membrane, from which it soon extricates itself, and which it leaves at the orifice of the puncture. These young crickets are whitish and very active, and generally conceal themselves in the thick June foliage of our woods or our orchards. At this time of their life they subsist principally on plant lice, eggs of insects, and other delicate animal food, and, if they can get nothing better, will exhibit their cannibalistic propensities by devouring the weaker individuals of their own kind. It is astonishing how rapidly, at this age, they will clear an Aphis-covered twig. Subsequently, as they grow larger, they are often content with a vegetable diet, and thus they perfectly combine in one species herbivorous and carnivorous habits. After the first molt, they begin to vary a good deal

in color, the females generally being quite dark. The mature insects were illustrated in my first Report (Figs. 77, 78).

I had, last summer, an extensive brood of these little crickets in one of my breeding cages, and succeeded in rearing them to the winged state, which they assume during the fore part of July. The male produces a very shrill noise by the friction of his front wings, but the female is silent.

This Snowy Cricket shares with his more robust Jumping companion in the nefarious midnight-work of gnawing, girdling or severing different parts of the grape thyrse, causing the berries either to shrivel or fall, and producing what is often known as "shanking." It is while the grapes are yet green that they are mostly severed, and the ground beneath vines is often scattered with this green fruit, where the cause of the trouble is little suspected. Such *useless* waste and destruction is doubly provoking, and as the virtues of their youth do not atone for the bad habits of their after-life, these jumping crickets must be classed with the bad bugs. The infested twigs often die beyond the punctures of both these species; and the best remedy is to cut and burn the twigs in winter.

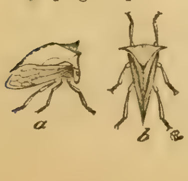
[Fig. 50.]



In his twelfth annual Report, (Trans. N. Y. State Agr. Soc., 1867, p. 889), Dr. Fitch elaborately describes these eggs, which he, for some unaccountable reason, and without question, refers to the insect next to be treated of—viz., the Buffalo Tree-hopper. He certainly never bred this last insect from such eggs, and how he could for a moment imagine that any but a much larger insect, possessed of a much longer ovipositor, could insert so many long eggs into the very pith of twigs, is difficult to conceive. The fact that he mistook the real slits made by this Tree-hopper, or an allied species, for the crescent cuts of the Plum Curculio (see 3rd Report, p. 38), and was thoroughly imbued with that error, may afford some explanation. My good friend has not, I regret to say, been in the habit of correcting his own errors; but nevertheless I draw his attention to this one—not as a fault-finder, but for the sake of truth. We are all liable to mistakes!

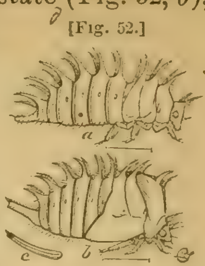
The egg-punctures of this Buffalo Tree-hopper (*Ceresa bubalus*, Fabr.) are represented above (Fig. 50). The punctures consist of a row, more or less straight, of little raised slits in the bark (*b*), in each of which, upon careful examination, may be found an oval, dark-colored egg (*a*, enlarged). These eggs hatch about the middle of May, and the young are at first brownish, with a formidable row of ten pairs of compound spines, and looking totally unlike the mature insect. After the first and second molts, they are still furnished with these sprangling spines on the back, but are of a paler color, with some transverse lilac-colored lines (Fig.

[Fig. 51.]



52, *a*). With the third molt, they assume the pupa state (Fig. 52, *b*), in which the wing-pads become conspicuous, the spines are reduced in size, and the prothorax is produced into a point behind. With the fourth and last molt, which takes place toward the end of July, the mature characteristics are suddenly acquired. This Tree-hopper is a yellowish-green, hunchbacked object, with two little horns on the prothorax, which render its name not inappropriate (Fig. 51, *a*, side view; *b*, back view). It subsists, during its whole life, on the sap of apple, pear and other trees; but never does serious injury. The female is furnished with a sheathed ovipositor (Fig. 52, *c*) well adapted for making the incisions described. In common with all the other insects of its Family, (Order *Homoptera*, Fam. *Membracididæ*), it has remarkable jumping power.

[Fig. 52.]

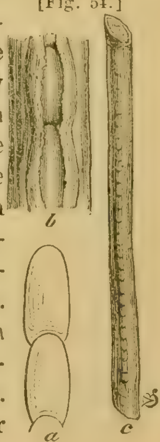


[Fig. 53.]

A fourth kind of egg-puncture, very similar to those just described, but with the eggs inserted more regularly, and more closely together, (Fig. 53, *a*, natural size; *b*, enlarged), is also frequently found on apple twigs. It is doubtless produced by some closely allied tree-hopper, but the species is not yet known.

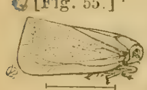
A fifth kind of puncture is found not unfrequently in the tender growth of sassafras. It consists of a continuous raised slit (Fig. 54, *c*) of the epidermis, into which are regularly crowded a series of elongate-oval, dirty yellow eggs, each 0.04 inch long, and the end of one pressed on to the top of the next, as represented enlarged in the figure (*a*, eggs extracted, *b*, within twig.) About the middle of May, these eggs produce little hoppers, which leave a thin and delicate pellicle attached to each egg-shell, at the point of egress, as is so generally, if not universally, the custom with *Homoptera* and *Orthoptera*. As soon as they begin to pump the sap of the tree on which they hatch, these insects copiously secrete a farinose or cottony substance, which completely covers them. They grow slowly, shed their skins but three times, so far as I have been able to observe, and by the first of September, or earlier, produce the Frosted Lightning-hopper (*Pœciloptera pruinosa*, Say).

[Fig. 54.]



This insect belongs to the same suborder as the preceding, but to the family *Fulgoridæ*, the insects of which are remarkable for their marvelously quick jumping power, and for the large size of the soft wings — some species looking much like moths. The species under consideration is quite common on a variety of trees, and varies from lead-color to pale green, and is dusted over with a fine white powder. Up to the time

[Fig. 55.]



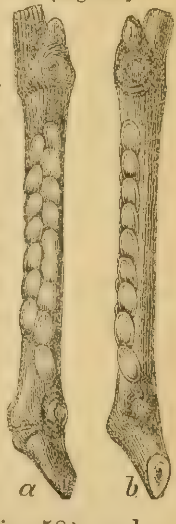
it acquires wings, the cottony secretion is always copious enough to cover all but the head.

[Fig. 56.]

A sixth kind of puncture is illustrated herewith, (Fig. 56), and is found in a variety of soft, fibrous plants, such as the more cylindrical parts of Indian corn, the stems of roses, and particularly those of the Raspberry. There are usually ten or twelve rounded punctures, at a distance of from half an inch to an inch, or more, from each other—the fibre of the plant being torn in shreds longitudinally. Upon cutting into these punctures, the wood is found to be discolored and dead, as far as they extend, and in the center of the pith, placed longitudinally, is an elongate, dull yellow, opaque, soft, more or less flattened egg, 0.22 inch long, and 0.04 wide, the anterior end tapering to a tolerably fine point, the posterior end more blunt. I have not yet succeeded in hatching the insect from these eggs, and it is impossible to say positively to what species they belong. But I strongly incline to believe that they produce our largest meadow-grasshopper, (*Orchelimum glaberimum*, Burm.), because I have had just such eggs deposited in cork by the female of this species, kept for that purpose in confinement, and have found it quite common where these punctures were abundant. It is a glassy green species, with some brown each side of the thorax, the female having a strong, smooth, cimeter-like ovipositor, and the male a transparent violin at the base of his front wings, which is principally instrumental in causing that incessant and continued singing or ringing so characteristic of our autumns.

[Fig. 57]

[Fig. 58.]



The hard, more or less flattened, slate-colored eggs, deposited in a double row, and overlapping each other as in the accompanying figures, repeatedly excite the curiosity of the inquisitive. Harris describes these eggs as belonging to the common Broad-winged Katydid (*Platyphyllum* [*Cyrtophyllus*] *concavum* Harr). He received them from Miss Morris, and whether it is on her authority or on his own that they have been given such a parentage, is not stated; but certain it is that the statement is a gross error, and has misled entomologists generally. Several years ago I hatched the insects from the eggs, illustrated at figure 57, and proved them to belong to the Oblong-winged Katydid (*Phylloptera oblongifolia*, DeGeer). As I found others which were somewhat flatter and broader, (Fig. 58), and as Harris's statement was unqualified, and he moreover expressly states that "in form, size and color, and in their arrangement on the twig,"

those of *oblongifolia* strikingly resemble those of *concavum*, I was led to suppose that the broader ones belonged to the latter. After hatching nothing but *oblongifolia* year after year from such eggs, and noticing structural differences in the ovipositors of the two insects, which seem to have escaped previous observation, I began to suspect that the eggs of *concavum* were deposited in a different way, and experience has sanctioned the suspicion; for, upon confining a number of pregnant females of *concavum*, I found that the eggs of this species are always thrust into some substance, or into crevices. When furnished with any soft material, such as cork, the females crowd it full of eggs.

To be brief—as I intend to give a more extended account of our Katydids in my next Report—we have in this latitude three species, which are quite common, viz: The two already named, and the Narrow-winged Katydid, (*Phaneroptera curvicauda*, DeGeer), easily distinguished by its narrower wings, and two conspicuous recurved appendages at the end of the male abdomen. If we examine the ovipositor of *oblongifolia*, we shall find that the terminal part is armed with strong thorns, or teeth, both above and below. By means of these and its jaws the female is able to rasp and roughen the stems on the outside of which her overlapping eggs are laid. The difference in size, and especially in thickness, which is so noticable in these eggs, depends on the variable size of the parent, and on the degree of maturity of the eggs. In the other two species, on the contrary, the ovipositor is perfectly smooth, and we find that the eggs are inserted. Those of *concavum* are 0.25 – 0.30 inch long, very flat, over thrice as long as wide, pointed at each end, with the edges beveled off or emarginate (Fig. 59, *a* side view, *b* front view, enlarged, *c*, *d* natural size). They are of a dark slate-color, and are thrust into crevices and into the softer parts of bark or of stems. The lower or first inserted end is protected by a dark, adhesive substance, which hardens and sometimes extends the whole length of one of the borders; and several eggs are usually pressed close to each other. Those of *curvicauda* are deftly inserted between the upper and lower epidermis, and along the edges of different leaves—those of oak being seemingly preferred. They are inserted contiguously, but not overlapping, and, though of about the same form as those of *oblongifolia*, are at first so much thinner as scarcely to cause any swelling of the leaf.

[Fig. 59.]

All these eggs swell or increase in thickness as they approach the hatching period. We may explain this fact on the principle of endosmosis with those which are imbedded in living plant tissue; but it is my experience that the wood or pith around such eggs is very generally deadened, and even if such an explanation were sufficient with the softer, imbedded eggs, it would not answer with the harder

ones of our Katydids. The increase in bulk is most apparent a few weeks before hatching, and in none is it so obvious as in those of *curvicauda*, which swell very materially, whether the dead leaves containing them have buffeted the winter's frosts and blasts, or been kept in a dry room. It is about as difficult to conceive the source of the matter causing this increase, as it is to understand the force which causes the continued revolution of the globular frog's egg while suspended in its gelatinous surroundings!

STINGING LARVÆ.

In the popular mind, nearly every creeping thing has the power to bite or sting. Through sensational items, which at certain seasons are the order of the day in many of our periodicals, the large Potato-worm (*Sphinx* 5-*maculata*), and some of its congeners which, like it, are ornamented with a horn near the tail, are looked upon with fear and trembling, under the delusive idea that said horn possesses poisonous and deadly stinging power. By the same false teaching most worms have become a scare to children, and even haunt and trouble "children of larger growth." So deeply have I known this superstition (for it can not be called anything else) to be rooted, that the good people of a certain household allowed their tomatoes to be utterly ruined rather than run the supposed risk of being mortally stung by handling the horned destroyers.

No class of animals, and few, if any, creeping things, are less deserving of this wide-spread fear and horror than are the larvæ of insects. Of the many thousand varied and distinct species which inhabit the United States, hardly more than two dozen have any power to cause inconvenience, and not one to do serious harm to man. In a few rare instances, the larvæ of some Diptera have been found in the human stomach, in the nostrils, or in flesh wounds; and Kirby and Spence mention, on other authority, that even Lepidopterous larvæ have been found in like situations; but it may be stated as a broad and very general rule, that insects in their larval state have no power to do direct injury to man, however annoying they may be in the perfect state. The few exceptions to the rule will be found among the Heteroptera and the Lepidoptera. It is of some of the latter which I propose at present to speak.

Many caterpillars will pinch a little with their jaws if they get a chance, and a few (such, for instance, as that of *Xylina cinerea*, 3d Rep., Fig. 57, and that of *Perophora Melsheimerii*) quite sharply, so as to draw a little blood from a tender part; but here there is nothing poisonous in the bite, and the great majority will not bite at all. A

few, again, have the power of causing a stinging sensation, which produces greater or less inflammation of the parts affected. Yet in every instance, this is a sort of urtication like that from a nettle, and not a voluntary sting like that of a bee or wasp. In no case is it dangerous, and the application of a little saleratus water (Reaumur found the rubbing of parsley beneficial) will soon allay the inflammation. Some of the larvæ possessing the power might be freely handled by the uninitiated without its being discovered.

Every one familiar with insects in Europe, will remember the irritating property of the hairs of the gregarious Processionary caterpillar (*Cnethocampa processionea*), or the so-called Yellow-tail Moth (*Liparis auriflua*). In these instances it is the irritating power caused by the fine barbed hairs, the tips of which get broken off after piercing the skin, and the dried hairs from a dead caterpillar or from an old web are more to be dreaded than those from the living larva, for they are more brittle.

I am acquainted in all with fifteen larvæ, inhabiting our State, whose spines have this urticating power,* but in every instance it is caused by the sharp prick and not by the points of the spines getting broken in the flesh. For lack of time to make the requisite illustrations, I shall at present give the history of only two, which, on account of their large size and acute sting, very naturally head the list. The first may be called the Black Stinger of the Oak, and I will now give its natural history.

---

* These belong mostly to the slug worms or Conchiliform larvæ, all of which, when furnished with spines or prickles, will doubtless prove to possess this urticating power. The following, I have, from personal experience, proved to possess it: *Lagoa crispata* (Smith), *L. opercularis* (Smith), *Euclea pœnulata* (Clem), *Euc. querciti* (H-S), and two other undetermined larvæ of precisely the same structure, *Parasa chloris* (H-S), *Phobetron pithicium* (Smith), *P. hyalinum* (Walsh), *Adoneta spinuloides* (H-S), *Monoleuca semifascia* G & R, and *Empretia stimulea* Clem. *Limacodes scapha* (Harr), and *Lithacodes fasciola* (H-S), have not this stinging power. The fifteenth stinging larva with which I am acquainted, belongs, strangely enough, to *Acronycta*. This species, as I learn from Mr. Lintner, is *xylinoides* Guen. It has the size and form of *occidentalis* Grote, or of the smaller specimens of *leutiocoma* G & R. In general appearance, some of the specimens bear a strong superficial resemblance to *oblinita*, but are easily distinguished by the smaller average size, the squarer wings, and the deeper, colder color, and heavier marks of the front wings. Guenée's description of the front wings, as "narrow and prolonged at the apex" would, I think, mislead, and he does not mention one character which is common to all my specimens (7), which is that the t. p. line is strongly relieved posteriorly, and blends with the ground-color basally. I append below a description of the larva and pupa.

While spending a day with Dr. Fitch, at Salem, N. Y., on the 24th of August, 1870, I found him feeding a larva of *Anisota stigma* (Smith), which he said had stung his little daughter badly; but though the spines of this larva produce a slight tingling sensation, it can not be likened to that of the true stinging larvæ, and is no more irritating than the prick from the spines of *Grapta*, or many other spinous larvæ.

The other species of the tribe to which *Maia* and *Io* belong, will doubtless prove to have the same properties in the larva state; and Mr. G. M. Levette, of Indianapolis, Ind., informs me that *Pseudohazis eglanterina* (Boisd), which, like *Maia*, deposits its eggs in a belt, also possesses urticating power; as he was cautioned against the too free handling of some larvæ received from California, and which fed on wild rose.

Acronycta xylinoides — *Larva* — Before last molt 1.10 inches long; diameter of middle joints, which are largest, 0.27 inch. Color of body lalaceous, mottled, and transversely dotted with dark brown, and with dark, interrupted, medio-dorsal, subdorsal and stigmatal lines, obsolete on thoracic joints, the medio-dorsal forming a series of Y-marks on the abdominal joints. Each joint with a transverse row of conspicuous warts, concolorous, except the superior abdominal ones, which are ferruginous, becoming paler on anal joints; 8 on jts. 1—3, 10 on the rest, the 4 superior on 11 quadrangularly arranged. Those in subdorsal space largest, more or less confluent, especially on the thoracic and anal joints, and with the space in front of them on abdominal joints, pale. Springing from these warts, a

THE BUCK MOTH OR MAIA MOTH—*Saturnia* [*Hemileuca*]. *Maia* (Drury).*

(Ord. LEPIDOPTERA, Fam. BOMBYCIDÆ).

This modest-looking but truly elegant moth was one of the first acquisitions to my cabinet many years ago. During a farmer's life of four years in Kankakee county, Ills., it was my fortune to spend many a day in the so-called "oak-ridges" lying along the Indiana line. Here, late in the months of October and November—when the still and hazy atmosphere, and the sombre brown of the craggy oaks, boded so eloquently the coming of cold to "rule the varied year"—when the rustling leaf under the horse's tread, or the modulated echoes of the woodman's ax were the only sounds of life, and animated nature seemed to have been wooed to Lethean slumber—this crape-winged moth would often flutter by as though loth to follow in the general sleep. It is one of the few moths which fly in mid-day, though in the breeding cage it shows a crepuscular habit, and is most active in the evening till dark, after which it remains quiet. It is because it is seen flying in the fall when the deer run that it has been commonly dubbed Buck Moth or Deer Fly. The wings are so lightly covered with scales that they are semi-transparent, and look like delicate black crape. The bands across them are cream-white, and broadest on the hind wings. These bands vary very much in width, and in nearly a hundred specimens

[Fig. 60.]

---

number of stiff, acute, rufous spines, (strongest dorsally) about ⅓ as long as the diameter of body, interspersed anteriorly, posteriorly and laterally with much longer bristles. Stigmata oval and bright yellow, (black in alcoholic specimen). Head small, dark copal-colored, with a yellow triangle in front. Venter concolorous, the legless joints with four small verrucose warts. Thoracic legs same color as head; prolegs same as body, both furnished with stiff, yellow hairs. The tips of spines are more or less black, as are the points on the warts from which they spring.

After last molt the warts are paler, except on joint 4, where they remain dark red, the subdorsal pale spaces in front of the confluent warts become more conspicuous, and are strongly relieved by the broadening of the dorsal and subdorsal dark lines, the Y-shape of the former being nearly obliterated.

Four specimens. Feeds on Oak, Willow and Rose, and I have also found it on *Rhus toxicodendron*, Persimmon and Peach.

Spins a dirty white, elongate, thin and compact cocoon within a leaf.

Chrysalis—like that of *oblinita*, dark brown, shagreened, coarsely and acutely on four first abdominal joints above, which joints have the hind borders raised and smooth. Anal joint unarmed. Like all other *Acronyctas* which I have bred, it wears away the head of its cocoon on emerging by persistent whirling—the moth secreting no liquid whatever.

The spines of the larva sting quite sharply, with slight inflammation of short duration.

* This insect and the succeeding one (*Io*) were both referred to the older genus *Saturnia* by Harris and other popular authors; but have since been very properly separated. Together with *Anisota rubicunda*, which follows, they belong to the very distinct subfamily *Ceratocampinæ* of the *Bombycidæ*. They rest with the wings closed, the hind ones extending a little in front of the anterior ones.

which I have bred at different times, those on the front wings more especially are sometimes narrowed so as almost to be obsolete, at others broadened so as to separate the discal spot from the black basal portion; and Mr. Lintner, who has recently given the most complete and minute account of the insect ever published,* figures and describes a bred male in which, on the front wings, they are entirely obsolete, and which, if it had been captured at large, would doubtless have furnished some describer the material for a new species. The female antennæ below, the hair on the thighs, and two small tufts behind the thorax, are brick-red, and the male differs from the female (Fig. 60) in having broader, black antennæ and a smaller abdomen, tipped with a large tuft of brick-red hair. The collar is cream-white, and the black hairs of the body more or less sprinkled with hairs of the same pale color.† It ranges from Maine to Georgia, and west to the western part of Kansas. Two closely allied species which may prove to be but geographical varieties are also described from California.

THE EGGS

Are deposited in naked belts (Fig. 61) of from 100 to 200, but not fastened together so tightly, nor in the same regular order, as those of the Tent-caterpillar of the Forest (3d Rep., Fig. 52, *a*). Holding firmly by all of her feet, the female stations herself upon a twig, with her head usually toward its end. She then stretches her abdomen to its fullest and fastens the first egg; another is then attached by its side, and so on, the body reaching round the twig without letting go the feet. In this manner, governed by the thickness of the twig, an irregular, somewhat spiral ring is formed and others added, until toward the last the abdomen is raised and the ovipositor brought up between the legs. The lower or first deposited rows, incline so as to almost lie on their sides. The color of these eggs is at first a pale greenish-cream, becoming more yellowish with age, and they contain a sticky, deep, blood-red fluid. Each egg is obovate, about 0.05 inch long, and compressed at the sides and at apex. The glutinous fluid, which covers them when deposited, gravitates toward the attached ends and sides, where, in consequence, it becomes thicker and dark. From experiment, Mr. Lintner proved that this gum was insoluble either in cold water, alcohol, ether or chloroform; and, boiled for an hour, it only softened a little to harden again upon drying.

(Fig. 61.)

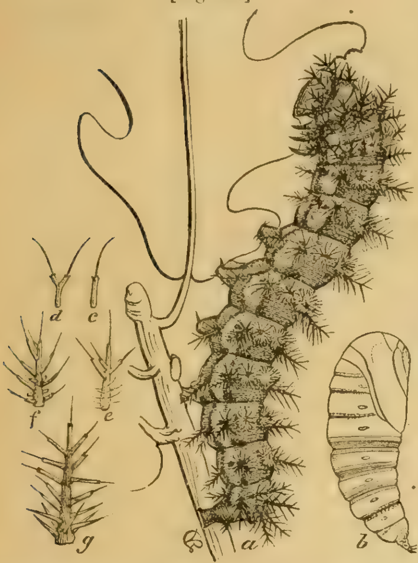
* *Entomological Contributions* in 23d Ann. Rep. N. Y. State Cab. Nat. Hist., 1869, p. 153.

† In three of my specimens these light hairs are very prominent, especially on the patagia, and these specimens approach so nearly *H. Nevadensis* Stretch (Illus. *Zygænidæ* and *Bombycidæ* of N. A., p. 107, Pl. 4, Fig. 10) that I should be much more inclined to consider the latter a geographical variety than a true species. Perhaps the same may be said of *Californica*, which appears to agree with Mr. Lintner's bred variety.

In confinement I have known them to be piled up on each other in a very irregular way, and I have found them on apple and received them on peach twigs from A. M. Shultz, of Troy, Mo., and R. H. Fitts, of Lawrence, Kansas. Yet the larvæ hatching from such eggs refused to eat the leaves of those trees, and commenced to die, until I gave them oak leaves—a fact which does not speak well for the supposed infallibility of instinct. Most of the moths, belonging to the same large family, deposit eggs readily whether impregnated or not; but in no instance where coition had not taken place have I known our Buck Moth to lay.

THE LARVA.

[Fig. 62.]



The ordinary appearance of the full-grown larva is given at figure 62. The color of the body is brown-black, covered with more or less conspicuous small oval yellow elevations or papillæ, and with a lateral yellow stripe, formed by the confluence of some of the papillæ, and by broken irregular yellow marks. The spines, during growth, exhibit all the forms in the figure, and I append, for those interested, a more minute account of the

LARVAL CHANGES.—The newly hatched larva is about 0.15 inch long. In the *first stage* it is black and granulated above, reddish-brown and smooth below, with a row of spots along the middle joints. The prolegs are brown. Head with a few scattering hairs. Spines placed in the normal position, namely, 6 (in longitudinal rows) on all joints except 11, where two dorsal ones are replaced by a single medio-dorsal one, an additional subventral one each side on jts. 1, 2, 3, 4, 5 and 10, and an additional medio-dorsal one on jt. 12. They consist of a thickened, sub-cylindrical, polished black stem, nearly as long as the diameter of the body, truncated at tip, which is coronated with three or four short points, and emits a long black bristle, which, under high magnifying power, appears barbed (Fig. 62, *c.*) On the thoracic joints the stem of the six superior rows is forked near its tip (Fig. 62, *d.*) In the *second stage*, the body remains the same, but the spines, which are now longest on thoracic joints, are more branched, with more hairs from the main stem, and the bristles from blunt ends comparatively short (Fig. 62, *e.*) In the *third stage*, the dorsal spines are still more branched, and often less truncated, so that the bristle is less distinctly separated and forms more nearly part of the tapering spine. The bristles also, especially on lateral spines, are longer and paler. During the latter part of this stage the characteristics of the mature larva are indicated. In the *fourth stage*, the two dorsal rows of spines on jts. 3—10, and the mesial one on jt. 11, are reduced to sub-conical tubercles or warts, fascicled with short stout, simple spines of a pale, fulvous color, tipped with black; those on jts. 1 and 2 remain much as before, but there is generally a fascicle of similarly fulvous spines a

the base of the latter. The other spines are somewhat stouter, with the blunt tips from which the bristles spring, more or less white. Characters of mature larva more patent. In the *fifth stage*, the granulations assume the form of whitish transverse-oval papillæ, each emitting from the center a minute dark bristle. These papillæ are mostly confluent around the stigmata, and, together with some irregular, pale yellow markings, produce a broad and pale stigmatal stripe. They are most sparse along the subdorsal region, just above stigmata, where, in consequence, the body appears darkest. In the *sixth stage*, at maturity, it may be thus described:

Average length, nearly 2 inches. Color, brown-black. Head, cervical shield, anal plate and legs polished chestnut-brown, the prolegs lighter, and inclining to venetian-red, with hooks more dusky and the true legs darker, inclining to black at tips. The dorsal fascicled spines, with the exception of a few short, black ones in the center of each bunch, are pale, rust-yellow, translucent, the tips mucronate and black; the other compound spines are black, with the blunt ends more or less distinctly white and translucent (but frequently crowned with minute black points, as in the first stage), and the sharp-pointed spinules arising from them dusky. They are generally enlarged and reddish at base, and an approach to the dorsal fascicles is made in the increased number and yellow color of the basal branches, especially in the subdorsal rows. Stigmata sunken, pale, elongate-oval; venter yellowish along the middle, the legs connected with red, and a reddish spot on the legless joints.

The above is the normal appearance of the larva in Illinois and Missouri; but it is quite variable. In some specimens the black predominates to such an extent, even in the sixth stage, that the papillæ are not very noticeable, and the lateral yellow band is obsolete;* while in others the yellow papillæ predominate over the black, and the lateral band is broad and continuous. The amount of light color in the spines is also very variable. It should also be stated that when just hatched, and after each subsequent molt, the color is at first uniformly brown; and that the spines for each coming stage are formed under the skin, and not within the old ones.

The young hatch with us about the middle of April, and are out sometimes before the leaves are ready for them; in which event, they survive many days without food. At this season they spin a moderate amount of web, by which they hold tenaciously to the twigs. They are gregarious, and in traveling have a fashion of following one another closely, and mostly in single file. As soon as the leader finds a suitable leaf, he crawls up the midrib to the tip, and the others follow and crowd each side along the edge. Should the leaf be too small to hold them all, the last remain on the twig; and—after the more fortunate ones have eaten and crowded back upon them—in their turn take the lead. The gregarious habit remains until after the last molt, though the original batch may divide into two or more. In the last stage they separate and scatter.

This is one of the few larvæ which pass through five molts, and it usually comes to its growth about the end of June, or in about two months from the time of hatching.

---

* All which Mr. Lintner reared seem to have been dark and without the lateral pale stripe; a fact which led him to question the accuracy of a brief description in the *American Entomologist*, (Vol. 1, p. 186), written by myself.

THE STING,

As already stated, is caused by the prick of the spines, and not by their getting broken in the flesh. From the fact that the spines appear hollow, one would naturally attribute their irritating power to some poisonous fluid which they eject into the puncture. But I have been unable to resolve any apical aperture, nor was Mr. Lintner more successful. Hence I infer that the irritating property belongs to the substance of which the spines are formed, and this opinion is strengthened by the fact that those of a dead larva, or of a cast-off skin which has been in my cabinet for several years, still retain the irritating power, though so brittle that it is not easy to insert them. All the spines have the same power, though the rust-colored, fasciculate ones along the back, being more acute and stouter, sting most readily; the aculei from the others being more fragile. The power is probably possessed from the time of birth, though the bristles in the first stage are too flexile to penetrate anything but the most delicate substance. In the second stage the sting is readily produced on the more tender portions of the body;* but until the rust-colored bunches of short porcupine-like spines appear on the back, in the fifth and sixth stages, the larva may be handled with impunity, and will hardly sting, unless the spines are pressed upon the more tender skin. Even when full grown, it may, with a little care, be handled without injury. The effect of the sting is a reddening of the punctured parts, and the early appearance of raised whitish blotches. These are replaced by purplish spots, which do not disappear for several days.

THE PUPA.

The larva, to transform, almost always enters the ground, and there, in a simple, ovoid cell, the prickly skin is shed, and the pupa state, outlined at figure 62, *b*, assumed. It is now of a deep brown-black color, heavy and rounded anteriorly, minutely shagreened or roughened, except at the sutures of legs and wing-sheaths, where it is smooth and polished. The margins of the three abdominal sutures next the thorax, and of that between the last two stigmata-bearing joints, are more or less crimped or plaited, while the three which intervene, and which are the only ones movable, are deep and transversely aciculate (as if scratched with the point of a needle) on the hind, and longitudinally and minutely striated on the front side. The body ends in a triangular, flattened, ventrally concave tubercle, tipped with a few curled, blunt, rufous bristles.

---

*Mr. Lintner, in the paper already cited, only noticed the stinging properties after the third molt or in the fourth stage, and asserts that "the ability to inflict a sting does not belong to all the spines of the larva, but only to those of the two subdorsal rows on segments three to ten, and the dorsal spine on segment eleven." This is, however, quite incorrect, so far as my experience goes.

ISSUING OF THE MOTH.

The moths commence to issue the fore part of October, the males almost always appearing first. Though the great bulk issue at this season, a few do not appear till the following spring, and occasionally remain in the ground till the second fall—a period of over fifteen months. It is difficult to conceive what influences should so retard a few individuals, and enable them to pass the heat of a second summer unaffected, when the species normally develops in a so much shorter time; and, though the exceptional fact is recorded by two independent observers, Mr. Lintner very naturally found it difficult to believe it without additional evidence. I can add my own testimony; for, from a batch of larvæ, which had all entered the ground before July 1st, 1871, one moth did not issue till October 8th, 1872. Such abnormal occurrences in insect life are by no means uncommon, and, though we may not be able to account for them, we can understand how they prove of advantage to the species. The eggs of our Buck Moth are among the few which remain unprotected and exposed to the severe winter weather, and, indeed, I know of none which are so completely at the mercy of the elements. Now, I have always noticed that some eggs, in a batch, failed to hatch—their vitality having, perhaps, been destroyed during the winter; and Mr. Lintner has recorded a similar observation. An unusually intense cold might destroy all the eggs over large extents of country; and, in such an event, the few belated pupæ would alone survive to perpetuate the species. That species are occasionally reduced in this wholesale manner, we have abundant proof; and, in this light, what at first appears to us an abnormity, becomes an important and necessary feature of the insect's economy. Thus, even occasional irregularity plays its part in adapting a species to its surrounding conditions, and becomes a necessary concomitant of the universal order and harmony in Nature!

FOOD PLANTS.

The leaves of our different oaks are the most natural food of this insect, and the black masses of prickly larvæ are sometimes quite abundant on the young Post, Black and Red oaks along the Iron Mountain region. My first worms were found abundantly on the Scrub willow (*S. humilis*), in Northern Illinois, in 1862; and I have also found them on a rose-bush. Maj. J. R. Muhleman, of Woodburn, Ills., also tells me that he has found them abundantly on the common Hazel, and Mr. Glover gives, as food-plant, the wild Black cherry.

NATURAL ENEMIES.

The poisonous qualities of the larval spines, however objectionable they may be to man, do not shield the wearer from the attacks of

other animals. We do not know positively that any bird attacks them, even while young; but Mr. Lintner caught the Modest Soldier-bug (*Arma modesta* Dallas) in the act. This bug is congeneric with and of much the same size and appearance as the Spined Soldier-bug, illustrated in former reports. Of true parasites, *Limneria fugitiva* (Say), a small Ichneumon-fly, which preys on several other insects, (Rep. 4, p. 41), and an undetermined species of *Microgaster*, have been bred from it—the latter by myself, and both by Mr. Lintner. I have also noticed, in one instance, a number of Tachina eggs behind the head of a larva in the third stage; but, singularly enough, they were shed with the third skin before hatching—the only case of the kind that has ever come under my observation. From another larva, however, I bred 7 specimens of the same Tachina-fly, which I have designated *anonyma*, and bred from so many other larvæ (Rep. 4, p. 129).

THE IO MOTH—*Saturnia* [*Hyperchiria*] *Io** (Fabr.).

(Ord. LEPIDOPTERA, Fam. BOMBYCIDÆ.)

[Fig. 63.]

This is one of our most beautiful moths, receiving its name from two conspicuous eye-spots on the hind wings, in allusion to the ancient Greek heroine, Io, who, as the fable went, was jealously guarded by the hundred-eyed Argus. The sexes differ remarkably in coloration. The male, (Fig. 63), which is smaller, is also much brighter colored, being of a deep yellow, marked, as in the figure, with purple-brown, the body and hind wings being of a deeper ochre-yellow. In the female, (Fig. 64), the purple-brown color predominates, and she is somewhat differently marked. The species shows considerable varia-

*= *varia* Walker—see Lintner *Ent. Contributions* II, p. 45.

[Fig. 64.]

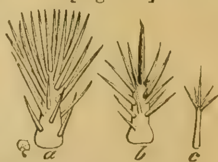
tion, both in color and pattern, and certain males in my possession range from pale cream-color to buff in the front wings.

The eggs are deposited in clusters on the under side of the leaf. The first description given of them is in the *Canadian Entomologist* (Vol. II, p. 29), by Chas. S. Minot, who describes them as "top-shaped." They are very much of the same form as those of *Maia*, being compressed on both sides and flattened at the apex—the attached end smallest. The color is cream-white, with a small black spot on the apical end, and a larger orange one on the compressed sides. A cluster found on Sassafras by Miss Murtfeldt contained about thirty eggs.

The larvæ begin to hatch about the end of June, and come to their growth in two months, after passing through five* molts, as in *Maia*. The hatching of eggs deposited at various times covers a considerable period, as larvæ are found as late as September first. As in *Maia*, the young larvæ are gregarious, feeding side by side, (like the Grape-vine Procris, 2nd Rep., Fig. 59), and they have a still more inveterate habit of following each other in single file. They differ from *Maia* in that they devour their cast-off, spinous skins, and in being less particular about their food. The full-grown worm presents

[Fig. 65.]

[Fig. 66.]



the appearance of figure 65, and is of a green color, with the longitudinal stripes at the sides white and lilac-red. In my experience, the urticating properties of this larva, which exist from the first stage, are keener than in *Maia*. At all events it can not be handled with the same impunity; for it has fewer of the bristle-ending spines, and more of the stout and acute spines which prick most readily. For the most part, these larvæ remain at rest during the day-time; and they prepare for their dif-

* Harris erroneously says four.

ferent molts by drawing together, with a little silk, two or three of the leaves of their food-plant—thus forming a screen and shelter. They separate more and more as they get larger, but a few may always be found in proximity, even in the last stage.

LARVAL CHANGES. — The spines are situated as in *Maia*, viz.: 8 on jts. 1, 2, 3, 4, 5 and 10; 6 on jts. 6, 7, 8 and 9; 5 on jt. 11, and 7 on jt. 12. In the *first stage* the dorsal rows have much the same structure as in *Maia*, consisting of a stem or tubercle nearly as long as the diameter of body, and bifid on thoracic joints, but the set of mere points around truncated end in *Maia*, are here lengthened into spines, and the terminal bristle is reduced and stouter (Fig. 66, *c*). The body is smooth, bright orange, and the spines are of the same color, with the terminal half of the dorsal and tips of subdorsal ones black. The head varies from copal-yellow to black, with a few pale hairs around the trophi. In the *second stage* the body becomes paler, but with a darker medio-dorsal and three yellow lateral longitudinal lines. The tubercles are more bulbous and sprangling, those of the dorsal row having a stout central and terminal black spine (Fig. 66, *b*), and, except near head, having no bristles or aculei. The subdorsal spines have a little black at tips, and the lower ones are pale and weak, consisting, toward the basal part of the tubercles, of mere bristles. The labrum and a V-shaped epistomal mark on head are pale yellow, and the black ocelli are relieved by a pale surrounding. In the *third stage* the tubercles become more fasciculate, with few of the spines black, except at extreme tips and toward head, where the stems are longer, and the terminal halves of the four upper ones, on jt. 1 more especially, are black, with pale bristles. The body still inclines to orange, but the yellow longitudinal lines are broader, and two additional somewhat broken ones, appear between the dorsal spines. The head is green on top and on the cheeks, and dusky in front, while the black Y sutures separate the yellow V mark. The stigmata are dusky. In the *fourth stage* the bases of the tubercles are more bulbous and yellowish-white, the general color of the body is greener, the substigmatal line being pale and distinct, except on thoracic joints, where it is obsolete, and bordered above by a broader stigmatal orange-red stripe. The spines are greener, mostly translucent, but opaque toward tip — those on posterior half of body inclining, more and more, to fuscous; the extreme tips are dusky. Stigmata pale fulvous. In the *fifth stage* the body is pale green above stigmatal line, darker below, with the stigmatal stripe more pink, the spines having still less black, and the dorsal ones shorter and more evenly shorn (Fig. 66, *a*). In the *sixth stage* there is little change, except in size, and the mature larva may be thus described:

Average length 2 inches. Color pea-green, the sprangling spines more yellowish, and frequently tipped with black, especially anteriorly, posteriorly and laterally; all which are substigmatal, and those on the thoracic and anal joints terminate in pale aculei or bristles; the others mostly taper to a stout point. A conspicuous substigmatal white line, bordered above with a broader lilaceous stripe, obsolete on thoracic joints, and containing pale, piliferous dots. Stigmata elliptic-oval, yellow, with dark brown annulus; venter green, with a few scattering white hairs, and two pale, lilaceous patches on all but thoracic joints, each patch containing oval, pale-green, piliferous spots. Cervical shield, anal plates and a spot outside of prolegs of the same lilaceous color. Legs pale brown, with whitish bristles, the prolegs with brown hooks. Head polished green, with black ocelli.

Considerable variation is shown in individuals, and in one batch which I reared, a single larva, during the second stage, showed such exceptional coloring as to attract attention. The spines were almost white, and it had distinct dorsal and subdorsal red lines, not possessed by the others. These peculiarities were subsequently lost.

When about to transform, it draws a few leaves together, generally near the ground, and spins a thin, weak cocoon of a gummy brown silk. The pupa is of the same general form as that of *Maia*,

somewhat lighter colored, lacking the plaited edges on the sutures described in that species, and having the hind side of the deep mobile sutures longitudinally and broadly striate or carinate, instead of transversely aciculate. There are some sparse, rust-colored, curled bristles on the abdominal joints, and the anal tubercle terminates in quite a bunch of them.

The moths frequently issue in the fall of the year, and some as early as the middle of September; in which case it is not known whether they or their eggs hibernate. They more often issue, however, during the following May. Unlike the exceptional *Maia*, they are doubtless nocturnal, as I have never seen them flying during the day-time.

FOOD PLANTS.

The species is a very general feeder. I have found it myself on the so-called false Indigos (*Amorpha fruticosa* and *Baptisia*, two species), on Sassafras, Black locust, Indian corn, wild Black cherry (*Prunus serotina*), and Willows. It has likewise been found on Elm, Hop vine, Balsam, Poplar, Balm of Gilead, Dogwood, Choke cherry, Currant, Cotton and Clover.* I have also taken the full grown larva from Ironweed (*Vernonia*), but without any other proof that it feeds upon this plant.

PARASITES.

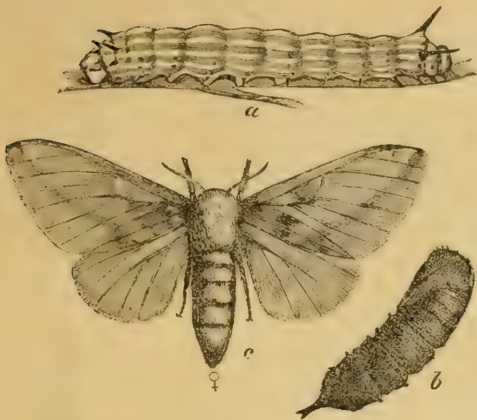
Parasitized larvæ are frequently met with, and the white cocoons intermingled with their spines, and of which I have reared great numbers, produce the same species of *Microgaster*, already referred to as parasitic on *Maia*. The Long-tailed Ophion (4th Rep., Fig 37) also breeds within it.

* For authorities, see Harrris (*Inj. Ins.*, 394); Fitch (*N. Y. Repts. 2d Vol.*); C. J. S. Bethune (*Can. Ent.* II, p. 20, and *Can. Farmer*, Sept. 15th, 1870); C. S. Minot (*Can. Ent.* II, p. 29); Mrs. H. C. Freeman (*Am. Ent.* II, p. 39); T. Glover (Monthly Rep. Dep. Agr., Nov. and Dec., 1866), and J. A. Lintner, as already cited.

THE GREEN-STRIPED MAPLE-WORM—*Dryocampa* [*Anisota*] *rubicunda* (Fabr.)

(Ord. LEPIDOPTERA, Fam. BOMBYCIDÆ.)

[Fig. 67.]



There is a striped worm (Fig. 67, *a*,) which at times very seriously affects our Soft and Silver maples, but more especially the former, and which was so unprecedentedly abundant last year in some of our western counties, and beyond into Kansas, that a brief notice will be looked for in this Report. To give some idea of the numbers in which it occurred in our sister State, I introduce the following letter:

DEAR SIR: We are very much troubled out here in Kansas with worms. You no doubt know some persons who are always afflicted with worms. Those, however, that I wish to ask you about (I mean the worms, not the people,) are those that are eating all the foliage off our shade trees—Soft Maples—they trouble none others.

About two years ago was the first I noticed; there were not a great many that year, but last year they came in increased numbers, so that many trees were eaten entirely bare, there not being a single leaf left. This year they are appearing by the million on the trees in my yard, and in fact on all the Soft Maples in this vicinity. The first you discover will be the eggs laid in clusters on the under side of the leaves, generally near the end of the limbs, on the new growth. They soon hatch and begin to eat, grow and spread over the trees, and when they have entirely stripped the tree they crawl down the body to the ground, under foot, into the houses and elsewhere in search of food. They grow to be about two inches long—great green worms.

The eggs are evidently laid by some kind of fly. In our city, and in fact in all this country, the Soft Maple, on account of its rapid growth, has been almost universally set out for shade trees, and this worm-nuisance has come to be a serious question.

If they are a thing that has come to stay—to appear and reappear year after year—I propose to cut my trees down, and plant something that is worm-proof. You may be conversant with this matter, and able to tell us at once their nature, and whether they are likely to be a permanent pest, and if there is any remedy for the nuisance. Doubtless they are in other parts of the country, but I have never seen any except in Kansas. If you can tell us anything about the matter, a letter from you would be most gratefully received by

Your obedient servant,

HORACE J. SMITH.

OTTAWA, Franklin county, Kansas, June 24, 1872.

Any one traveling through Kansas last fall must have been struck with the absolutely naked appearance of the Soft maples, which are very extensively used, and highly prized for ornament and shade, and may be found in every thrifty town. A beautiful belt on the grounds of the Agricultural College at Manhattan was allowed to suffer like the rest, and by the middle of September, could scarcely boast of a leaf.

I have known this insect for many years, and it is a wide-spread species, extending throughout the Eastern States and Ontario. The fact that the Soft maple is indigenous along the streams, in the bottom lands of Kansas, will account for its excessive multiplication there, compared with the more eastern portions of the county.

The eggs from which the worms hatch are deposited in batches of thirty and upward, on the under side of a leaf. Each is about 0.05 inch long, sub-oval, slightly flattened, translucent, and pale greenish, becoming more yellow, and showing the black head of the inclosed larva just before hatching.

LARVAL CHANGES.—In the *first stage*, the larva is cylindrical, yellow, with a large black head, and the spines hereafter described forming little black tubercles of nearly uniform size, and without the greater prominence of those on joint 2. In the *second stage*, the head is browner and the spines and stripes of the mature worm more apparent. In the *third stage*, the mature characteristics are acquired, and there is subsequently little change. The full grown larva may be thus described:

Average length, 1.50 inches. General color, pale yellowish-green; longitudinally striped above alternately with eight very light (almost white) yellowish-green lines, and seven of a darker green, inclining to black, the medio-dorsal one usually darkest, and showing palpitations. Characterized by two black, blunt, anteriorly-projecting horns on joint 2; two lateral rows of posteriorly-projecting, more pointed, shorter spines, one (the largest) below and one above stigmata, and most prominent on joints 10 and 11, which are here somewhat dilated and tinged with rose-red. When examined with a lens the body, both above and below, is found to be thickly studded with transparent granulations, and there are four dorsal, polished, sub-obsolete spines, the anterior on upper edge, and the posterior on lower edge of second dark stripe, and most prominent on joints 11 and 12. Head more or less intense copal-yellow, the ocelli on a black ground; stigmata, in lower dark line, oval, black, with a pale central line; joint 1, with six black elevations on anterior edge; anal shield flattened, greenish, with a black blotch superiorly, and margined with eight black spines, the two terminal stoutest; venter black, with pale mesial line, and a prominent black spine each side, and sometimes others less prominent; legs greenish or yellowish, the thoracic and anal marked with black, the abdominal with rufous clasps.

Varies much; specimens in last molt often with black predominating, the dark lines being jet black, the two lowermost often coalescing; all sometimes coalescing on joint 1, and anal shield, and the legs being almost entirely black. Other specimens with the pale colors predominating.

Hundreds examined.

The worms are longitudinally striped with pale and darker green lines, and are chiefly distinguished by two anteriorly projecting black horns on the top of joint 2, and by having joints 10 and 11 a little dilated and rose-colored at the sides. They go through four molts

and come to their growth within a month, when they descend into the ground and become chrysalides.

The chrysalis (Fig. 67, *b*) is of a deep brown or black color, very much roughened, and coarsely punctate or pitted like a thimble, with curved horns about the head and thorax, especially at base of antennæ, a ring of sharp, conical teeth around the anterior edge of the movable joints, (stoutest dorsally), one around the middle of the penultimate joint, and several irregular thorns on the apical joint, which terminates in a long projection, bifurcate at tip. The movable sutures have a few coarse punctures on the posterior part, and very fine longitudinal striæ on the anterior part, which, at the edge, has a ring of small, blunt-pointed elevations.

In due time this chrysalis, by aid of the spines with which it is furnished, works its way to the surface and gives forth the perfect insect, which is a most delicate moth, of a pale yellow color, shaded with pink, as in the figure (*c*) which represents the female, the male having a somewhat smaller abdomen, and broader, more pectinate antennæ. This moth may be called the Rosy Dryocampa. It varies a good deal. In our western specimens the yellow predominates, the rose color being but faintly visible. Ordinarily the front wings might be described as rose-colored, with a yellow band running diagonally across the middle, and broadest on the anterior margin. I have seen eastern specimens where the rose color was quite intense on the front wings, and where the hind wings, which are more generally pure yellow, have a rosy band across them. Other specimens I have bred which were almost white or colorless.

With us there are two broods of this insect each year, the first brood of worms appearing mostly during the month of June, and giving forth the moths the latter part of July; the second brood of worms appearing in August and September, wintering in the chrysalis state, and not issuing as moths till the following May. I have bred the second brood from eggs laid by the first; and last year not a worm was to be found after the 15th of September, where a week previously they had been swarming.

Dr. Harris gave to the genus, to which this moth belongs, the name of *Dryocampa*, meaning "oak-caterpillar," because all the other species of the genus feed on oaks; and though our Maple worm prefers the Soft maple, it will nevertheless feed also on Oak, as it has been found thus feeding by my friend Wm. Saunders, of London, Ont., and I have myself fed it on Oak in confinement.

NATURAL ENEMIES.

How far this insect is controlled by birds is not known, but it has certain parasites which very effectually aid in this work, and whose existence explains the fluctuation in the increase or decrease of our Maple worm. Prominent among these parasites is the same *Tachina anonyma* (*ante* p. 133) which preys within so many other larvæ, and which has been reared by my correspondent E. A. Papineau, of To-

peka, Kas., and by myself. A second and more beautiful species of Tachina-fly* (Fig. 68) also attacks it. It is easily distinguished from all other species of the genus with which I am familiar by the bright golden-yellow of the third and fourth abdominal joints, which have only the hind borders black, and it may be vulgarly called the Gold-banded Tachina-fly.

[Fig. 68.]

TACHINA [BELVOSIA] BIFASCIATA (Fabr.)—♂—Length, 0.50 inch; expanse, 1.00 inch. *Head* broader than thorax; face broad, silvery-white, with purplish reflections, and garnished with the usual black bristles; front more dusky, with two rows of large, incurved bristles, interspersed, as usual, with numerous smaller ones, and divided by a smooth, depressed, dark brown stripe; occiput dark, with the three triangularly arranged ocelli amber-colored; labium ferruginous, with hairs of same color; maxipalps ferruginous, with short black bristles; eyes smooth and dark purple-brown; antennæ with the two basal joints brown, the second nearly thrice as long as first, the third darker, flattened and nearly thrice as long as second, the setæ black; hind part of head covered with dense white hair. *Thorax* quadrate, polished, black, except at corners, which are brown, with a bluish cast inclining to pruinescence anteriorly, where alone the vittæ are distinct; the usual transverse suture distinct, and the larger bristles numerous around border and in four lines on dorsum; scutel tinged with brown: wings fuliginous, almost opaque, veins brown; alulæ dull white; legs strongly bristled, black, with ferruginous pulvilli. *Abdomen* stout, first and second joints deep blue-black, *third and last joints golden-yellow, with only the posterior borders black;* two stout medio-dorsal bristles from posterior edge of jts 1 and 2, (stoutest on 2), and a ring of them around 3 and 4.

One ♂ bred from *Anisota rubicunda*, and one captured by Mr. Lintner at Center, N. Y., in July.

This is evidently the insect briefly characterized as *Musca bifasciata* by Fabricius, (*Syst. Antl.* No. 78), and subsequently more fully by Wiedemann, (*Aussereuropæischer Zweifl. Ins.,* II, p. 305), who, however, describes the 3rd antennal joint as *four times as long as 2nd.* Still later it was referred to the genus *Nemoræa* by Macquart, and to the genus *Latreillia* by Robîneau-Desvoidy. The last named author again referred it to a still different genus, *Lalage*, (*Dipt. des Env. de Paris,* I, p. 563), where it is described from Fabricius's typical specimen as having a golden band around the *middle of the second and third* abdominal joints. The genus *Lalage* is founded on the "absence of bristles on the apex of the first abdominal joint," so that I can not see how our insect could be referred to it. Macquart gives good reason for believing that his *Senometopia bicincta* and R-D's *Belvosia bicincta* represent the female, and, consequently, unites them into one species, under the name of *Belvosia bifasciata* (*Dipt. Ex.* Tom. II, Part 3, pp. 55–7).

The female (which I have not seen) differs in the somewhat broader face, in the 3rd joint of antennæ being only twice as long as the second, and in the abdominal bands being white instead of golden.

We thus see that this one species has been construed to represent four modern genera, and, though this may well be called pretty fine hair-splitting, the different characters which gave birth to it are important and conspicuous compared to those upon which some of our modern genera in other Orders have lately been founded. Is it any wonder, therefore, that the field-naturalist should get heartily disgusted at such unnatural, so-called generic distinctions!

It may be well to add that Meigen (*Beschr. d. bek. Eur. Zweifl. Ins.* Vol. IV, p. 381) described (in 1824) a *Tachina bicincta*, which has a white ring around the *base of the 2nd and 3rd* abdominal joints; and that Macquart's figure of *Belvosia bifasciata* (sex not indicated) shows the head and face, and the abdominal bands much narrower than in

my ♂. If, in the future, the specimen here described should prove distinct, it may be called *auricincta*, by which MS. name it has been ticketed in my cabinet. The fact mentioned by Macquart that, though found more particularly in Brazil, *Belvosia bifasciata* has been received from Philadelphia, and bred from *Citheronia regalis*, would strongly indicate that we have to do here with the same species, and that the differences just noticed are either defects in the drawing or variations. In the captured specimen in my possession the characteristic golden bands have become effaced by greasing.

Finally, the same little friendly Ichneumon-fly, (*Limneria fugitiva*, Say, Rep. 4, p. 41), which was already known to breed in a closely allied congener, (*Dryocampa stigma*, Sm.), has been bred from it by my lady correspondent, Mrs. Mary Treat, who has forwarded me specimens. The larva of this parasite forms its own cocoon within the disemboweled skin of its victim, which it kills almost always in the third stage.

REMEDIES.

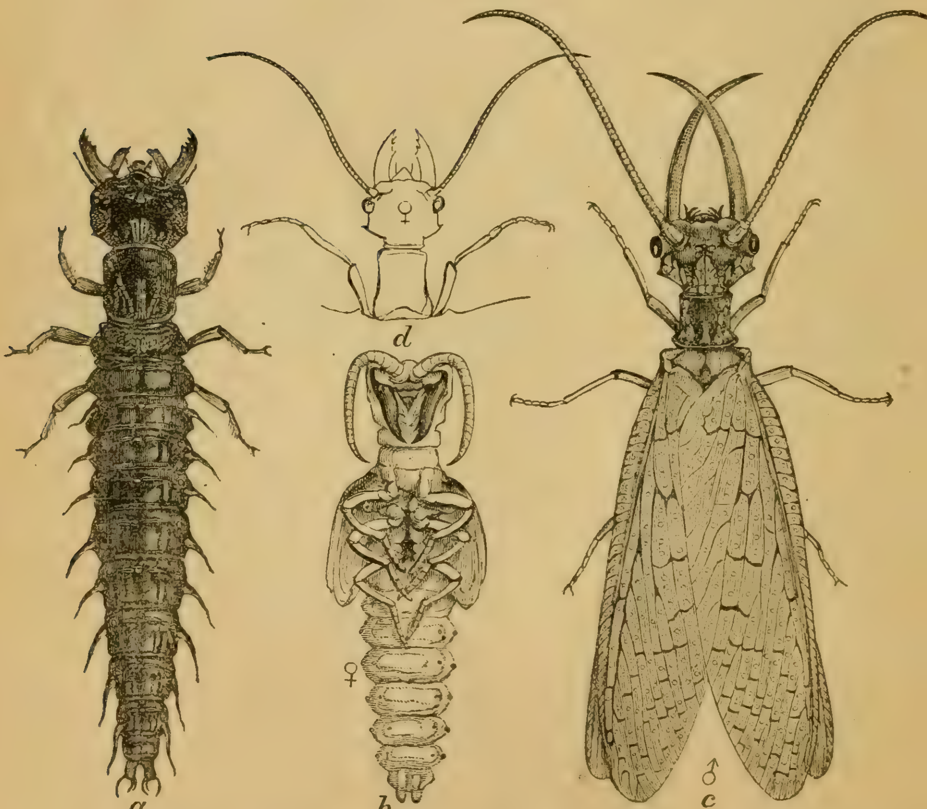
This insect is seldom so exceedingly abundant two years in succession. In 1867 it stripped the soft maples around Peoria, Galesburg, Princeton and Monmouth, in Illinois, but attracted no particular attention the following year. The worms hold on to the tree tenaciously, and are not easily jarred down ; and, before entering the ground, they scatter great distances away from the trees, so that it is impracticable to hunt for and destroy them while in the chrysalis state. The best way to counteract their injuries is to keep a close watch for the moths and eggs during the latter part of May, when they may be destroyed in great numbers. The worms, when about to leave the trees, may also be entrapped, by digging a trench either around the individual tree or around a grove or belt. The trench should be at least a foot deep, with the outer wall slanting under. Great numbers of worms will collect in it, or bury themselves in its bottom, and may easily be killed.

INNOXIOUS INSECTS.

THE HELLGRAMMITE FLY—*Corydalus cornutus* (Linn.).

(Ord. Neuroptera, Fam. Sialidæ.)

[Fig. 69.]



This immense fly and its larva have been sent to me by Walker Evans, of Moselle, R. E. Pleasant, of Louisiana, and others in differ-

ent parts of the State. It is the largest of our Nerve-winged insects, and is tolerably common throughout the Eastern and Middle States, and into Ontario. It is so conspicuous and so characteristically marked that, with the accompanying figures, which are of natural size, no detailed descriptions are necessary.

[Fig. 70.]

Its eggs (Fig. 70) are oval, about the size of a radish seed, and of a pale color, with some dark marks. They are deposited in the summer months in closely-set patches of fifty and upward, upon reeds and other aquatic plants growing along running streams, and the newly-hatched larvæ drop or crawl immediately into the water, which they inhabit till the end of the following spring. The young larva has not been described, but, judging from analogy, it will resemble the full-grown form, (Fig. 69, *a*), which is of a dark-brown color, variegated with lighter brown—the abdominal joints being tough and leathery, and the head and thoracic joints horny and polished.

Most aquatic larvæ transform to the pupa state within the water, but this larva quits the water when full-fed, as do the others of the same family, and crawls about for days seeking a place wherein to transform. We find, therefore, that nature has abundantly fitted it for living in both elements, by giving it, first, two rows of nine breathing holes or spiracles, placed in the usual way along the sides of the body, (the first between joints 1 and 2, and the others on the anterior portion of joints 4–10), which enable it to breathe out of the water; and, secondly, two sets of nine gills or branchiæ, which enable it to breathe in the water. These gills or respiratory filaments are placed just below the spiracles, and one on each side of each abdominal joint, except the 9th, and on the terminal subjoint. They are more or less covered with fine hairs, (inadvertently omitted in the figure), and between them may be noticed small tufts of such hairs. Besides these lateral filaments, there is, ventrally, a pair of rust-brown, spongy masses of short fibres, one on each side of joints 4–10, and a somewhat similar central patch on the terminal joint and subjoint. Dr. Hagen supposes these to be the true gills, but they may be looked upon as accessory gills. The lateral filaments assist in swimming, and we shall also notice, at the tip of the body, a pair of curved, double hooks, which assist in climbing or in moving backward.

This larva feeds on other aquatic insects, such as the larvæ of May-flies (*Ephemera* family) Shad-flies (*Perla* family), etc. It abounds most in rapid-flowing streams, and generally in such as have a rocky bottom, upon which it moves slowly about. After leaving the water, about the beginning of June, it travels, in the night-time, sometimes to comparatively great distances—having been found nearly a hundred feet from its former habitat. At this season, it is sought as

fish-bait, and is called by fishermen a "crawler" or "hellgrammite." It can pinch with its formidable-looking jaws, but not forcibly enough to draw blood. Mr. Walsh mentions a most curious incident in connection with its larval wandering,* which I quote in full:

"A most respectable man, who keeps the toll-bridge over Rock River, where this insect is very abundant, informed me that on several occasions its larvæ had fallen down one of his chimneys. His idea was that they must have bred there, but that, of course, is out of the question. The statement was confirmed by his wife, and I have no doubt of its truth. In 1863, I threw a larva of this insect into the Mississippi to examine into its customary mode of progressing in the water, which, as I found, was by crawling along the bottom, not by swimming. As it emerged from the water, it climbed with ease up the stump of a large white elm, which was stripped of its bark, and as smooth as any carpenter could have planed it. The stump was three feet high and upright, and when it had reached the top it commenced descending on the opposite side; but, after a while, lost its foothold and fell into the water again. The pair of 2-clawed appendages at the tail are used with much effect to assist it in climbing. The building which it must have climbed to reach the chimney, down which it is stated to have fallen, was only a low, one-story wooden one."

In preparing for the pupa state, this larva burrows into the earth, where it forms an oval cell, or hides under some large stone, piece of wood or other substance. Here, in about two weeks, it casts its tough larval integument, and assumes the form of figure 71, lying in a curved position in its cell, with the head, wing-pads and legs deflexed on the breast. Figure 69, *b*, was made from a spread and straightened skin before I had become acquainted with the living larva; and though it does not convey a truthful impression, will serve to better display the appendages. The color is yellow, with traces of the brown mottling of the larva, rudiments of the lateral appendages, but not of the spongy masses, and a few hairs scattered over the exposed parts. The spiracles are more conspicuous, and the upper jaws stronger and olive-green. The pupa state lasts but a few days, and the perfect insect issues during the month of July. It is nocturnal in habit, and hides, for the most part, in obscure places during the day. It is sluggish at this time, and, if approached, will drop sooner than fly, or raise its head and abdomen, and open its jaws menacingly.

[Fig. 71]

There is no perceptible sexual difference in larva or pupa, unless it is, as stated by Haldeman,† in the rather larger size of the jaws of the male. This similarity of the sexes, especially in the pupa, is the more remarkable that in the imago state they differ so greatly. The

* *Proc. Phil. Ent. Soc.*, Vol. II, p. 265.

† History and Transformations of *Corydalus cornutus*, by S. S. Haldeman, A.M., communicated to the "American Academy of Arts and Sciences," Nov. 18th, 1848. In this paper the transformations of the species are for the first time given, and the anatomical structure well illustrated.

male (Fig. 69, *c*) is remarkable for having his upper jaws — which in the female (Fig. 69, *d*) are normal and fitted for biting — prolonged into incurved, prehensile appendages of the form of a grain-cradle finger, and smooth and cylindrical, except at tips, which are pointed and minutely notched. As Mr. Walsh first pointed out,† this modification is evidently to enable him to embrace the soft body of the female, as it can not well have any other use. The body of the Hellgrammite fly is soft, and were the jaws of the male horny, and armed with teeth, in securing the female they would injure her, and thus defeat rather than aid procreation. In the large Stag-beetle or "Buck-bug" (*Lucanus elaphus* Linn.), on the contrary, where both sexes have very hard, horny bodies, the upper jaws in the male are greatly prolonged, but very stout, and armed with sharp prongs, the better to enable him to seize the female.

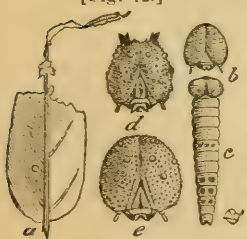
In these two cases we see how wonderfully the homologous organs have been modified in opposite directions to accomplish the same end. We find in Nature innumerable such curious contrivances and modifications, which at once excite our wonder and admiration. To quote Mr. Walsh's own eloquent words: "In so elaborate and diversified a manner does Nature adapt her plans and patterns to the ever-varying conditions of animated existence; and with such consummate care has she provided that the great fundamental law shall everywhere be effectually carried out — 'Increase and multiply and replenish the earth.'"

It is worthy of remark that in both these large insects in which the male upper jaws are so modified, this sex is far more common than the other. It is probably owing to the fact that the female seldom wanders away from her breeding place, and is, therefore, less often seen than her more restless and adventurous mate.

THE GOAT-WEED BUTTERFLY—*Paphia glycerium* Doubleday.

ADDITIONAL FACTS IN ITS HISTORY.

[Fig. 72.]



In my second Report (pp. 125–8) I gave an illustrated account of this insect, which was, however, incomplete, and in some few respects imperfect. Having since reared hundreds from the egg to the imago state, and otherwise carefully observed its habits, I am now able to supplement and complete the natural history of one of the most interesting of our N. A. butterflies.

† *Practical Entomologist*, Vol. II, p. 107.

THE EGG.

The egg, now described for the first time, is usually fastened singly, (though I have found as many as six on one leaf,) and not very firmly, to the under side of a leaf. It is perfectly smooth, shiny, globular, translucent, pale yellowish-green, and 0.035 inch in diameter—often (unnaturally) flattened at top. It has always hatched, with me, within five, and sometimes in four days after deposition.

Thus, while the larva of *Paphia* reminds us of *Goniloba* and the chrysalis of *Danais*, the egg recalls *Papilio*.

THE LARVA.

The newly hatched larva is of the same color as the plant, and invariably commences feeding at the tip of a leaf, stripping it down the midrib, upon which, between meals, it rests exposed, (Fig. 72, *a*), and in this respect much resembles the young *Limenitis dissippus* at the same age. The leaf-case which it inhabits later in life is not made till after the first, and sometimes not till after the second, molt; and from the facts that the young larva does not need it, and that the full-grown larva is often seen feeding under a broiling sun, I infer that the case is not so much intended for shelter, (the opinion formerly held), as for a shield against enemies, hereafter mentioned.

Larval Changes.—In the *first stage* the mature characteristics are already indicated, and there is less change in this than in most Lepidopterous larvæ with which I am familiar. The form is less cylindrical, and the head is smoother, with the tubercles sub-obsolete (Fig. 72, *b*); but it is similarly mottled with brown. The ocelli—5 in number, 3 of them larger than the others—are black, and placed some distance back of the antennæ; the sutures are well defined by dark lines, and there is a dark line on the neck, behind the head. The papillæ on the body are *less* numerous, and arranged more in transverse rows, there being four tolerably distinct transverse wrinkles to each joint. The dark spots between the papillæ, *and which are mere surface marks*, though minute, are distinctly visible, and two of the pale dorsal papillæ on the anterior wrinkle of each joint are larger than the rest. In the *second stage* the head (Fig. 72, *d*, enlarged) is more warty and more bilobed, with the three black ocelli still more separated from the others; it is pale laterally and behind, but dark on the flattened face, with the papillæ white, and conspicuous among them four large conical ones, in a transverse row, above epistoma, which is itself marked with a more or less cordate, pale figure, and another V-shaped, narrower, pale line along the suture; on the top are two prominent, black, bluntly-bifid tubercles, with two smaller but similar white ones between and just behind them, and laterally between them and the ocelli a simple, conical dark one. On joint 5 dorsally, and 8, 9 and 10 laterally, there is considerable black between the papillæ, while the whole dorsum of 11 and 12 is dark, and the anal shield is brownish: the four more or less distinct transverse rows of papillæ to each joint are now interspersed with more minute ones. In the *third stage* the head is proportionally larger than before, with the tubercles relatively reduced in size, and some of the formerly white ones are fulvous, except at tip. The papillæ on the body are more numerous, with the intervening non-elevated dots, pale rust-brown. Usually these coalesce into 3 darker spots dorsally on joint 5, and into one each side of 8, 9 and 10, (Fig. 72, *c*, enlarged), while the dorsum of 11 and 12 is frequently black. In the *fourth stage* the tubercles of the head are again reduced (Fig. 72, *e*, enlarged) very much as in the first

stage; the papillæ are more numerous and more uniform in size, and in some specimens sub-obsolete; the dark markings are more often lacking, as before described, (Rep. 2, p. 127), but sometimes so prominent as to give the worm a brown hue. Considerable variation in the markings of the head may also be noticed in different individuals of the same age.

Like the larva of the Archippus butterfly, it goes through but three molts, and, like that larva, it furnishes an excellent illustration of the fact that the head increases in size between the molts. It matures very rapidly, and often acquires its full growth within three weeks. In suspending for the transformation to chrysalis, the body is bent almost in a circle, the head being brought close to the anus; and so rapid is the transition, during hot weather, that by five o'clock P. M., I have had the dry and hardened chrysalis from larvæ which were not suspended till 10 A. M., of the same day. During the suspension of the larva, a pale transverse elevation (corresponding to that of the future chrysalis) appears distinctly across the middle of joint 7, and it is very patent that the head of the chrysalis is formed under the head of the larva — that the pro, meso and meta-thorax correspond to joints 1, 2 and 3, and that the second pair of larval spiracles is covered by the hind wing-sheaths in the chrysalis, while the ninth larval pair becomes obsolete and closed.

The transverse ridge across the abdomen, and the ridges around the wing-sheaths and the head, are white, with a lilaceous tint in the fresh chrysalis, and the dusky spots are arranged in eight longitudinal rows, two dots to a joint. The anal clasp consists of a rounded knob, densely covered with short, dark brown barbs, and connected with it ventrally is a conspicuous black cordate mark.

NEW FOOD PLANT.

The Goat-weed occurs very sparingly in the immediate vicinity of St. Louis, and not till we reach Highland, Illinois, on the Vandalia railroad, is it found in profusion. The butterfly is, nevertheless, quite common. Suspecting, from these facts, that it must breed on some other plant, I soon discovered such to be the case. While *Croton capitatum* is rare, another species of the same genus, the *Croton monanthogynum* Michx., is very abundant, and especially just over the river, at East St. Louis. This plant is rather more woody, grows a little lower, and has a much smaller, deeper green leaf than *capitatum;* and, though separated from *Croton* by some botanists, and called *Engelmannia* by one of them, Dr. Engelmann himself considers it a good enough *Croton.*

Unless very well grown on rich soil, several leaves are necessary to make a case, and the larva knows well how to adapt itself to the circumstances.

The perfect imitation of the food-plant by the larva is remarkable, for those found on *capitatum* are generally paler than those on *monanthogynum.* It is upon this last plant, later in the season, that I

have found so many dark specimens, the dark spots characteristic of the third stage enduring till the fourth, and the purple-brown frecklings between the papillæ so numerous as to make the sides, more especially, quite dark. Suggestively enough, the leaves of the plant at that season are almost universally covered with freckles of exactly the same color. On this plant, also, the chrysalis is invariably suspended under a parasol of leaves connected by silken threads, and so effectually is it hidden from view that a person not acquainted with the insect might travel for a day over ground where he would necessarily disturb one at every step, and yet remain perfectly unconscious of the fact.

TWO BROODS EACH YEAR.

It is generally believed that the species is single-brooded;* but this is evidently a mistake. Though I have not reared one generation from the other, I have no doubt that, like *Archippus*, it is double-brooded, because I have watched females depositing the fore part of September, which, from their fresh appearance, could not have hibernated. The females, in all probability, deposit as soon as the food-plants appear; and as this is rather late in the season, we seldom find any larvæ before the middle of July. Butterflies are produced from this first brood of larvæ during the month of August, and during that month, September and often into October—or until the plants dry up or are frozen—the insect may be found in all stages. Last year, on the 3rd of October, I found eggs and young larvæ, which were doomed to a sorry death, since a few days later a frost killed and blackened the plants upon which they occurred. The second brood of worms, as would naturally be expected, is far more numerous than the first, and, as in so many other species, the two broods doubtless overlap each other.

ITS WINTER QUARTERS.

That, as with *Archippus*, the butterflies hibernate, there is no longer any doubt whatever, as I have kept them throughout the winter, and so has Mr. Muhleman. Mr. Hayhurst also writes:† "During winter, (1870,) in February, a tree was felled on the line of the railroad on which I was at work. As it fell it split open and was found to be hollow. The cavity was partly filled with dirt and hickory-nut shells; but among the stuff that fell out were some twenty butterflies, mostly *Vanessas*—*Antiopa* and *Atalanta*. But among these were

*Mr. L. K. Hayhurst, of Sedalia, writes to Mr. Wm. H. Edwards (Butterflies of N. A., Vol. I, p. 139,): "This species has but one brood." Mr. J. R. Muhleman *(ibid)* writes: "I am satisfied there is but one brood." I think I can safely say that Mr. Muhleman is now of a different opinion, having himself had the chrysalis as early as the 5th of August.

†In Edwards's "Butterflies of N. A.," previously mentioned.

seven specimens of *glycerium*." In the fall of the year this butterfly is of frequent occurrence around persimmon trees, attracted by the sweet of the cracked and ripened fruit. Later in the season it congregates in small bevies around willows, collecting on wounded parts of the boughs, where the sap is exuding; and such congregations are usually accompanied by a few *Graptas*. The flight of *Paphia* is swift and strong, and specimens are difficult to capture. They rest suddenly, and then the leaf-like form and protective coloring of the fast-closed wings effectually screen them from sight. Faded, and often dilapidated, specimens may be seen flying, on warm days, early in the month of April.

NATURAL ENEMIES.

I have, on several occasions, found the newly hatched larva stiff and dead—apparently ichneumonized. The Spotted Ladybird (*Hippodamia maculata*, Rep. 1, Fig. 49) is abundant in all stages on *Croton*, and probably feeds on the eggs and young larvæ of *Paphia*, as well as upon a pale *Aphis* commonly found on the plant. In the breeding cage I have also had the eggs destroyed by *Syrphus* larvæ, while several insectivorous wasps, and notably the Painted-wing Digger-wasp, (*Ammophila pictipennis* Walsh, Fig. 73), are constantly seen exploring the Paphia-inhabited plants. But the most persistent of the enemies is the selfsame *Tachina archippivora*, (Rep. 3, p. 150), which infests *Danais Archippus*, and which I have bred quite numerously from late specimens of *Paphia*—the parasites issuing from their victims, sometimes while these are in the larva, but more often after they have assumed the chrysalis state; then entering the ground and issuing as flies early the following spring.

[Fig. 73.]

ON A

NEW GENUS IN THE LEPIDOPTEROUS FAMILY TINEIDÆ:

WITH

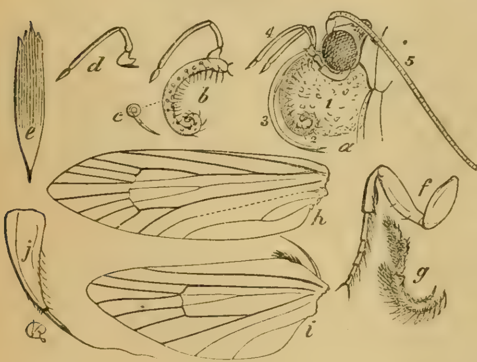
REMARKS ON THE FERTILIZATION OF YUCCA.

[Read before the St. Louis Academy of Science, at its regular meeting, September 2nd, 1872.]

PRONUBA. Nov. Genus.

GENERIC CHARACTERS.—*Front wings* (Fig. 74, *h*) elliptical, the apex subacuminate; disc closed, though somewhat indistinctly between marginal veins 5–8: 12-veined, exclusive of submedian (1 *a*); costal vein stout, connected with subcostal near base, and not extending beyond middle of wing; the subcostal vein sends, from about one-fourth its length from base, a branch which reaches costa where the latter commences to round off; it also sends, from about the middle of the wing, a branch through the discal space, forming an accessory discal cell, and sometimes considerably passing the disc, and forking outside, so as to form marginal veins 7 and 8, though more often forking just at the transverse discal vein; a feeble disco-longitudinal veinlet starts independently near the base, forks near the middle, and forms a second accessory discal cell; submedian vein distinct only near the margin, and indicated by an opaque line along the basal half of the fold; internal vein feeble, and bifid at basal third. *Hind wings* (Fig. 74, *i*) broad, subacuminate at tip; shoulder slightly produced and armed, in the ♂, with a long spine, and in both sexes with a tuft of long scales; 8-veined, exclusive of submedian, (1 *a*), which is distinct; disc entire; costal vein extending three-fourths the length of wing; an independent, feeble, disco-longitudinal veinlet, forking about the middle of the wing, the upper branch sometimes considerably passing the disc, and then forking into marginal veins 5 and 6, but more often forking at transverse vein; internal vein feeble and simple. *Head* (Fig. 74, *a*, ♀) free, sparsely haired; epicranium flattened or depressed; ocelli obsolete; clypeus large; eyes round and salient; antennæ filiform and simple in both sexes, nearly one-half as long as front wing, the basal joint long, bulbous, and twice as stout as the others; maxillary palpi (Fig. 74, *b*) very long, 5-jointed, *the basal joint in the* ♀ *produced*

[Fig. 74.]



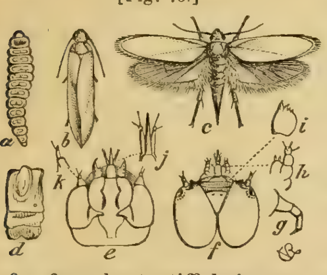
into a long, stout, cylindrical, prehensile tentacle, armed with spines springing from flattened tubercles (*c*); *this joint in the ♂ a mere blunt-pointed tubercle* (Fig. 74, *d*); the other joints almost smooth; 2nd, short, stout, and directed backward; 3rd, more slender, and as long again as 2nd; 4th, thrice as long as 3d; 5th, as long as 2nd, slender and subfusiform; labial palpi (Fig. 74, *g*) moderately covered with hair-like scales, reaching nearly to base of antennæ; 3-jointed; basal joint curved and stout; 2nd, half as long and straight; 3d, short and fusiform; tongue long and smooth. *Legs* with the usual single spur on the front, a pair on the middle, and two pair on the hind tibiæ. *Abdomen*, ♀ with the terminal joint laterally compressed, long, horny, bare; the sheath of the ovipositor acute; the ovipositor when extended very long, fine, and thread-like; ♂ shorter, blunt, and slightly swollen at tip; the genital hooks large, symmetrical; the upper edge entire and thickened, the lower edge excavated about the middle, with a dark tooth in middle of excavation.

Approaches in the venation of the wings such genera as *Anaphora* Clem. and *Amydria* Clem., but is at once distinguished from all other known genera by the characters given, and especially by the maxillary palpi. The variation in the wing venation affords another illustration of the unsoundness of the principle of founding genera on the pterogostic characters alone, especially when taken from one or two individuals only.

PRONUBA YUCCASELLA, n. sp. (Fig. 75, *c*).

Average expanse, ♀ 1 inch; ♂ 0.90 inch. *Front wings*, above, uniformly silvery-white, the scales loosely set; fringes concolorous; beneath, pale fuscous, with a brassy reflection; paler internally; fringes either concolorous or paler; costa with a brush of dark hairs. *Hind wings* semi-transparent, pale fuscous both above and below; paler internally, the fringes white and the brush on shoulder dark. *Head* white; antennæ and tongue dingy yellow; maxillary palpi of same color, with the exception of tentacle, which is darker; labial palpi with scales on 2nd joint dark brown above; eyes black. *Thorax* white. *Legs* dingy yellow, more or less covered with pale scales. *Abdomen* with the terminal joint in ♀ always bare, with the exception of a few short, stiff hairs near tip, and the scales on the other joints very loosely attached.

[Fig. 75.]



Described from 9 ♂s, 15 ♀s.

I take the present occasion to describe this new genus, not because it is so characteristic and anomalous, but because, firstly, the species belonging to it has such very interesting habits; and secondly, there is much yet to learn of these habits, and I wish to draw the attention of entomologists to the subject.

Of late years, and more especially since the publication of Mr. Charles Darwin's interesting work on the fertilization of Orchids,* we have come to understand more and more the important part which

* On the various Contrivances by which British and Foreign Orchids are fertilized by Insects London, 1862.

insects play in the fertilization of plants; and the old idea, that color and perfume in flowers were intended for man's especial pleasure, is giving way to the more natural and philosophic view that they are useful to the plants by attracting the needed insects.

In Dr. Asa Gray's recent little work, "How Plants Behave," etc., instances enough are given, in an admirably plain and lucid style, to show the manner in which many flowers are curiously and elaborately constructed so as *just not to do* of themselves what must necessarily be done for them in order to prevent degeneracy or extinction of the species. Some plants, as Fritz Müller proved, are so self-impotent that they never produce a single seed by aid of their own pollen, but must be fertilized by that of a distinct species, or even of a supposed distinct genus; while in some cases the pollen and stigma mutually act on each other in a deleterious manner.* The wind is an important agent in the fertilization of certain plants, and some are fertilized even by the higher animals; but by far the greater number are fertilized, or more strictly speaking, pollenized, by insects; while the number of species (termed *Entomophilæ* by Delpino) which absolutely depend for pollenation on insect agency is not inconsiderable. These insect pollenizers belong to several Orders, but mostly to the Hymenoptera and Lepidoptera. A familiar example is furnished by our milk-weeds (*Asclepias*), the pollen-masses of which may often be found adhering in pairs to the legs of bees and other insects, and sometimes in such quantities as to prove a real detriment and incumbrance to the bearers. Every year I receive specimens of such pollen-burdened bees, which are generally supposed to be infested with some parasite; and Mr. James D. Meador, of Independence, lately sent me a very gloomy account of the dangerous condition of his apiary from this cause. Each of the numerous flowers which constitute the well-known umbels is curiously constructed so that the pollen-masses, which look like little flattened, ovoid pieces of wax, can only come in contact with the stigma by artificial means; and we find that they hang by a bent stalk, attached to a flattened, ovoid, brown organ, having a cleft which catches the claws or tarsal hairs, or the fine hairs surrounding the trophi, of insects climbing over the umbels.

With most of the plants of this kind now known, fructification may be brought about by the aid of more than one species of insect; and none, perhaps, offer a more striking instance of dependence, or more curious floral mechanism to allure, than do the Orchids. They display an infinitude of curious contrivances and adjustments for the purpose. In the genus *Habenaria*, for instance, the peculiarities of which are described by Dr. Gray, we find flowers that, in some cases, strongly recall butterflies; a separate pocket for the nectar; the pollen bound together in masses by elastic threads, so as to lessen the

* See Darwin's "Animals and Plants," etc., II. p. 132.

chances of loss; and the base of the stamens forming flattened, sticky discs, placed in the best possible position for adhering to the head parts of a moth or butterfly endeavoring to reach the nectar. In all these features, and others that might be mentioned, there is remarkable adaptation; and the flowers of many species, as they unfold their petals, seem not only to invite, but to court and crave, the intervention of some scaly-winged marriage priest of "glorious color and glistening eye," who shall at once procure a suitor and perform the nuptials.

Yet here we have adaptation of the plant only, and, except in one or two rare instances, as, for instance, in that of a Madagascar Orchis (*Angræcum sesquipedale*), where the nectary is so deep that its nectar can only be reached by a moth with a very long tongue, our Orchids are not dependent for pollenation on any one Lepidopterous species, but may be aided by many which have tongues of sufficient length. Our Yuccas, on the contrary, seem to depend for assistance, so far as we now know, on the single little Tineid which I have described, and, for this reason, are among the most interesting of entomophilous plants. At least such is the case with the capsule-bearing species, i. e., those which have dry, dehiscent pods; and I will here premise that my observations have been made* upon a filamentose-leaved species in common cultivation about St. Louis, and which Dr. Engelmann takes to be *Y. puberula* or *Y. glauca*.

Dr. Engelmann has made some interesting observations on the fertilization of Yucca,† and to him I am indebted for drawing my attention to the fact that the plants of this genus must rely on some insect or other for fertilization. The sagittate anthers open a little earlier than does the perianth, and expel the pollen grains, which, being glutinous, remain attached in different sized lumps to the inside of the flower. The stigmatic tube contains nectar, and is connected with the ovarian cells, and the pollen must be introduced into the tube, but can not be so introduced without artificial aid.

There are several insects that frequent our Yuccas about flowering time. Some, doubtless, feast on the pollen, while others feed either by gnawing into the young fruit or pumping the juices there-

---

* The fructification of such *Yuccas* as bear fleshy, pulpy fruit, of which *Y. aloifolia* may be taken as the type, has not been studied; but, even with this last-mentioned species, the facts, so far as known, strongly indicate that *Pronuba* is principally if not solely instrumental in bringing it about. Its seeds are infested with our *Pronuba* larva, though not to the same extent as those of the dehiscent species. It would be premature to speculate until we have further facts; but it is not at all unlikely that the seeds of the fleshy pods are less congenial to the larvæ, and that a smaller percentage is produced from the eggs consigned to such pods by the moth. In addition to the *Pronuba* larva in the seeds, the fruit of *Y. aloifolia* nourishes a smaller, white, apodous larva, which is found in the pulp, sometimes in considerable numbers. It may be traced from slight depressions on the outside, and shows Hymenopterous affinities. It occasionally gnaws into the seed from the outside, but its legless character will at once distinguish it from the larva of *Pronuba*, which will be described further on.

† See Bulletin of Torrey Botanical Club, Vol. III, No. 7.

from;* but the only insect which I have found actively engaged in the pollenation is our little Tineid, which may be known in popular language as the Yucca Moth.

During the day-time, we may, by knowing what and where to seek, often find this moth, either singly or in pairs, resting with folded wings (Fig. 75, *b*) within the half-closed flowers. It is then not only hidden, but well protected by the imitative color of the front wings with that of the flower. If we visit the plants after

> " * * * * the garish day
> Has sped on his wheels of light away,"

and when, with full-blown perianths, the Yucca stands in all her queenly beauty, and sends forth her perfume more strongly upon the night air, we shall, with a little patience, meet with this same moth flitting swiftly from flower to flower and from plant to plant—the dusky nature of the hind wings and of the under surface of the front wings almost completely offsetting and neutralizing, when in motion, the upper silvery whiteness of the latter, and thus still rendering the insect a little difficult of detection. It is principally the male which we thus see flying, and, by aid of a "bull's eye," we shall find the female for the most part busily at work in the flowers. *He*, with stronger wing-power, can afford to pass in the most pleasurable way the few brief days allotted him; but *she* is charged with a double duty, and loses little time in its performance.

Before she can carry out the maternal task of continuing her race, she must act as foster-mother to the plant in order to insure a proper supply of food to her larvæ, which feed on its seeds. With her maxillary tentacle, so wonderfully modified for the purpose, she collects the pollen in large pellets, and holds it under the neck and against the front trochanters. In this manner she sometimes carries a mass thrice the size of her head (Fig 74, *a 1*). Thus laden, she clings to the top of the pistil, bends her head, thrusts her tongue into the stigmatic nectary, and brings the pollen-mass right over its mouth. In this position she works with a vigor that would indicate combined pleasure and purpose—moving her head and body from side to side, and apparently making every effort to force the pollen into the tube. Such is the method by which our Yuccas are fertilized.

*I have taken the following insects from the flowers: COLEOPTERA—*Anthonomus signatus* Say, whose larva I have known to feed on certain Aphidan Hickory galls—*Chauliognathus Pennsylvanicus* (DeGeer), and *C. marginatus* (Fabr.). Both these insects have the maxillæ peculiarly modified into slender, pilose, extensile setæ or feelers, which doubtless resemble in function the tongue of moths, and enable them to lap honey. I once thought these might have something to do with the pollenation of the plant, and possibly they do in a small degree; but I could never find them near the stigma, and their sole object seemed to be to feed upon the pollen, for which purpose their jaws are well suited. They are found on a variety of pollen-bearing plants, such as *Spiræa*, *Rubus*, *Solidago*, etc., while as larvæ they are carnivorous—the first named being one of the principal enemies of those notorious fruit depredators, *Conotrachelus nenuphar* (Herbst) and *Carpocapsa pomonella* (Linn.)—*Euryomia melancholica* Gor. & Perch, a chafer very fond of eating into the flowers and fruit of a variety of plants. HETEROPTERA—*Lygus robiniæ* Uhler—*Orthotylus discoidalis* Uhler—*Cyllocoris scutellatus* Uhler—*Theognis phyllopus* Uhler (=*albicinctus* Say). The last is notably found on Yuccas, but the others more commonly on other plants, and they all derive nourishment by puncturing and sucking—their punctures causing little rusty specks on the fruit.

The foregoing account of the insect's habits is founded on repeated observation; but we now come to that portion of its career to which I more especially wish to call attention, and which must be considered hypothetical until confirmed by future investigation. Yet I feel as certain of the correctness of my conclusions as though they had been demonstrated.

For want of sufficient time, I have been unable to catch the moth in the act of oviposition; but from careful examination, I am satisfied that the eggs are not deposited on the outside of the fruit. They are either thrust into it from the side or from the stigmatic opening, following, most probably, the course of the pollen tubes. I strongly incline to the latter view, for, though many Lepidoptera are furnished with extensile ovipositors, which enable them to thrust their eggs into crevices and other orifices, I know of none which actually puncture. Nor have I been able to discover any trace of punctures leading to eggs.

Neither have I been able to discover the egg *in situ;* which is not to be wondered at, however, as when examined in the female abdomen it is found to be long, narrow, soft and flexible, and of the exact color of the flesh of the young fruit. The ovipositor is so very fine and extensile that it may be thrust into the most minute and narrow passage.

If, a day or two after the flowers have withered, (between June 15 and July 5 in the latitude of St. Louis with the species mentioned), we carefully dissect the young fruit, we shall often find it to contain from one to a half dozen, but more generally two, young larvæ. They are always found within the nascent seed, and their bodies are, at this time, so much of a color and consistence with the surrounding pabulum, that we could hardly detect them but for the comparatively large, dark jaws. The larva retains its white color till after the last molt, when it acquires the carneous tint so common, at that age, to fruit-boring moth larvæ. It is then characterized as follows:

Description of Larva.—Average length 0.55 inch. Broadest on thoracic joints, thence gradually decreasing to extremity, which is quite small. (Fig. 75, *a*). Color carneous, with a paler greenish tint below. No piliferous spots, but a few very minute and short stiff hairs springing from the ordinary positions of such spots. A transverse dorsal wrinkle, on each of the principal joints, more or less distinctly divided in two by a medio-dorsal depression, which is sometimes slightly bluish. Joints deeply incised and with a lateral, substigmatal, longitudinal wrinkle. (Fig. 75, *d*). Thoracic legs stout, but short, with three joints and a claw. *No prolegs.* Stigmata (9 pair) forming a small rufous circle on anterior portion of joints 1 and 4–11. *Head* (Fig. 75, *e*, *f*, *h*, *i*, *j*, *k*) partially retractile, copal-colored; epistoma sharply defined; labrum slightly pilose; mandibles stout, rounded, and with four acute teeth, each diminishing in size from without; maxillæ with the inner lobe rounded and furnished with (usually 2) short fleshy hairs, the palpi 4-jointed, the terminal joint with bristles; labium prominent, with the spinneret conspicuous and the palpi 2-jointed—the first joint long, with a fleshy hair at tip, the second small, spherical, and also terminating in a fleshy hair;

antennæ 2-jointed, the terminal joint with a bristle; ocelli pale, around a dark crescent. Cervical shield flattened and not well defined.

White when young. Mostly curved in the fruit like the larvæ of *Curculionidæ*. Described from many specimens.

Two larvæ are seldom found in the same seed-row, and each one, on attaining full growth, consumes only the inside of from fifteen to twenty seeds. Each pod contains, on an average, upward of two hundred of these seeds, disposed in six rows, and might consequently sustain a dozen larvæ; so that when, as is usually the case, there are not more than two such larvæ to a pod, an abundance of perfect seed remains to perpetuate the plant. Yet sometimes every seed will be destroyed, especially in the species with smaller capsules.

It is quite possible that the moth may, at times, introduce the pollen into the stigmatic tube without consigning any of her eggs to the fruit, and we should naturally expect to find some capsules uninfested with her larvæ. But I have this year examined hundreds of capsules around St. Louis, and some in South Illinois, and not more than four or five per cent. were uninfested. Sometimes every pod on the same plant had its worms, while at others half the pods on a given panicle would be free of them. From the very large per centage of infested pods, I conclude that oviposition naturally and immediately follows fertilization, unless the moth be disturbed.

When mature, the larva bores a hole through the capsule, drops by a web to the ground, burrows a few inches below the surface, and constructs an oval cocoon of earth, lined on the inside with silk. Here it doubtless rests in the larva state through the fall, winter and spring months, and completes its transformations about the time the Yuccas begin to bloom; for it is a very general rule with Tineidæ that when they hibernate in the preparatory state, it is as larvæ—the term of the chrysalis state being brief.

The only natural enemies of the larva that I yet know of are ants. These omnivorous creatures often get into the capsule and devour the worm when it is about to leave, and its burrow may frequently be found crowded with them.

Though another year must roll around before the latter part of our Pronuba's history, as here given, can be positively substantiated, let me hope that the next blooming-season of our Yuccas will find other eyes than my own watching her ways and methods.

We have in this little moth a remarkable adaptation of means to an end. There is between it and its food-plant a mutual interdependence which at once excites our wonder, and is fraught with interesting suggestions to those who are in the habit of reasoning from effect to cause. Whether we believe, as I certainly do, that this perfect adaptation and adjustment have been brought about by slow degrees through the long course of ages, or whether we believe that they always were so from the beginning, it is equally suggestive of that same law and harmony so manifest throughout the realm of Nature.

The peculiar structure of the flower which prevents self-fertilization, though on a superficial view it strikes one as a disadvantage, is in reality a great benefit; while the maxillary tentacle of the female moth is very plainly an advantage to her species in the "struggle for life;" and it is quite easy to conceive, on Darwinian grounds, how both these characters may gradually have been produced in the course of time from archetypal forms which possessed neither. These peculiarities are, moreover, mutually and reciprocally beneficial, so that the plant and the animal are each influenced and modified by the other, and the same laws which produced the beneficial specialization of parts would maintain them by the elimination of all forms tending to depart from them.

It may be that the glutinous nature of the pollen renders consectaneous its accumulation by the spinous maxillary tentacles of the female moth; and that, when she is sipping nectar, the vigorous working of head and body from side to side is simply an effort to get rid of an incumbrance. It may be that all her actions are the result merely of "blind instinct," by which term proud man has been wont to designate the doings of inferior animals; but for my part, I have not been able to watch her operations without feeling that there is in all of them as much of purpose as there is in those of the female *Pelopœus*, who so assiduously collects, paralyzes, and stores away in her mud-dabs, the spiders which are to nourish her young; or in the many other curious provisions which insects make for their progeny, which, in the majority of instances, they are destined never to behold. Nor can I see any good reason for denying these lowly creatures a degree of consciousness of what they are about, or even of what will result from their labors. They have an object in view, and whether we attribute their performances to reason or instinct depends altogether upon the meaning we give to these words. Define instinct as "congenital habit," or "inherited association," and most of the doings of the lower animals may be very justly called instinctive. But I can not help thinking that the instinctive and reasoning faculties are both present, in most animals, in varying proportion, the last being called into play more especially by unusual and exceptional circumstances; and that the power which guides the ♀ *Pronuba* in her actions differs only in degree from that which directs a bird in building its nest, or which governs many of the actions of rational man.

I will conclude by referring to one practical phase of this subject. As the insect and its food-plant are inseparable under natural conditions, the former doubtless occurs wherever the latter grows wild. Pods of *Y. angustifolia* which I gathered on the Black Hills of Colorada, in 1867, all show the unmistakable holes of egress of the larvæ; while those of *Y. rupicola* from Texas, of *Y. Whipplei* from California, and of others from South Carolina and Texas, now in the herbarium of Dr. Engelmann, all show this infallible sign of having been

infested. Through the courtesy of the same gentleman, I have also received the moth, taken around Yuccas, from South Carolina, and the pods of several species from the same State and from Texas, while the larvæ were yet working in them. There is every reason to believe, however, that beyond the native home of these plants the insect does not occur, except where it has naturally spread or been artificially introduced; and it is an interesting fact that, so far as I am able to learn, the dehiscent species in the northern parts of this country and in Europe never produce seed.

The cocoons containing the dormant larvæ can be very conveniently sent by mail from one part of the world to another, and by their aid our transatlantic florists may yet have the satisfaction of getting seed from their Yuccas without any personal effort.

[I have been led to reproduce this article from the Academy Transactions: first, because I wish to lay the facts before the reader; secondly, because I fear that, through unavoidable delay in the publication of said Transactions, it would otherwise not be given to the public in time to lead to relevant observations in other parts of the country the coming summer. I have given but an inkling of the interest attaching to the subject, and made but a commencement in the record of facts.

From an abstract of the paper, made at the Dubuque meeting of the American Association for the Advancement of Science last August, the leading thoughts have been published in several periodicals both of this country and Europe, and have elicited the following facts:

J. W. B., of Flushing, L. I., says: "In my own garden, the *Y. filamentosa*, Gray, blooms and matures its seed annually. I have never been able to discover the intervention of any insect to assist fertilization, nor have I ever failed to secure the prompt germination of seed taken from any well-matured capsule."—[*Bulletin Torrey Bot. Club, Aug.* 1872.

It does not strike me as strange that J. W. B. should have failed to observe the moth, when it had hitherto escaped the notice of both botanists and entomologists. As, however, after more carefully examining his capsules, he subsequently found the perforations of the larvæ, (*ibid*, Nov., 1872), he will no doubt find the moth next year by properly seeking it.

Three large plants of the Adam's-needle, or Beargrass, (*Yucca filamentosa*), in our garden near New York, produced fine clusters of capsules this autumn; upon examining them we found that apparently every seed-vessel either contained an insect, or had a hole showing where one had escaped. The capsule of this Yucca consists of three cells, and generally but one of them was inhabited by the larva,

which destroyed the seeds in that, while the contents of the other two cells were untouched. All the capsules were one-sided or contorted, owing to the presence of the caterpillar. * * * A very observing friend who made extensive experiments with seedling Yuccas, in the hope of obtaining some new varieties, is quite sure that he has obtained crops of seed without any of the distortion of the capsule to which we have referred. * * * During a recent visit to Georgia, we found *Yucca gloriosa* in fruit. The fruit of *Y. filamentosa* is a dry capsule, while that of *Y. gloriosa* is pulpy, and when quite ripe is as soft as a banana. We examined a number of fruits of *Y. gloriosa*, and failed to find any distortion, perforation, or other indication that an insect had entered or made its exit.—*American Agriculturist*, Dec., 1872.

Yuccas Seedling.—I think there must be an error in regard to Yuccas not producing seed in Europe, owing to the non-attendance of the fertilizing insects. I remember, while at Dulwich, in the summer of 1868, some plants of *Y. filamentosa* produced a good crop of seeds, which germinated freely, and gave us a nice lot of plants, which seems to indicate either that the little moth is in the country, or that at least during warm summers the plants can manage very well without it. I dare say the Messrs. Smith could confirm the above statement.—T. Smith, Newry, in *Gardeners' Chronicle*, (London), Oct. 19, 1872, No. 42, p. 1390.

These extracts prove that the Yucca moth occurs on Long Island, and around New York, and indicate that other insects occasionally pollenize the flowers. The experience of Mr. Smith, in England, is as interesting as it is exceptional; but until we learn whether or not the work of the larva was manifest, no safe conclusions can be drawn. Other insects may have been the pollenizers, or *Pronuba* may have been locally introduced with seed from America. This last view may not appear very plausible, but if both sexes of the insect were, by some chance, introduced into a locality where Yuccas of blooming age were growing, there is no reason why they should not multiply; and such chance introduction is not impossible, since the larva not unfrequently remains in the capsule after the seed is ripe, where it fastens a number of the riddled seeds together into a sort of cocoon, which might easily pass unnoticed in gathering seed; and, if buried in the ground with such seed, would in time give forth the moth.

As bearing on the subject of the insect's range, I will add that I have since examined the wild *Y. angustifolia* around Manhattan, Kansas, and always found traces of *Pronuba*; but that of seventy plants, including several species in the garden of Meade Woodson, of Kansas City—a gentleman who is a great admirer of the genus—not one has yet produced seed. Mr. Edgar Sanders, of Chicago, tells me that plants of *Y. flaccida* do not there produce seed. Mr. Henry Wheatland, of Salem, Massachusetts, says that *Y. filamentosa* never produces seed there; and I learn from Professor Gray that it is equally barren at Cambridge. We have seen how irregularly some insects develop, and how this irregularity (*ante* p. 132) becomes excessive when the

species may be benefited thereby. Now the blooming season of our Yuccas is comparatively brief, and it is quite evident that those *Pronubas*, which do not issue within the appropriate time, must perish without leaving progeny. We might, therefore, expect to find the habit of issuing at the proper season, inherited through no one knows how many generations, very strongly fixed and difficult to break up; and such is the case to a remarkable extent. Some insects I have had no difficulty in forcing or causing to give out the imago prematurely, by submitting them to artificial conditions of heat and moisture. Not so with *Pronuba!* for, while I was quite anxious to breed a few to the chrysalis state before publishing this Report, and, for that purpose, kept a number at a mean temperature of about 80° all through the winter, every one of them is, at this writing, (April 10th), yet in the larva state.

Thus my inference, that it hibernates as larva, proves correct, and we may likewise infer that the chrysalis will be furnished with teeth or spines, by aid of which to work itself to the surface of its earthy shroud.

The following extract from a letter by Mr. H. T. Stainton, of England, and dated September 25th, 1872, will prove valuable as the opinion of our greatest micro-lepidopterist: "The *Pronuba yuccasella* is a most curious insect. The bare, horny hinder segments of the female remind me of some of the females of the genus of Longhorns *Nemotois*, such as *scabrosellus*, which lays its eggs at the bottoms of scabrous flowers, where a thickly scaled abdomen would be ill-suited to its purpose. The remarkably bull-headed appearance of your *yuccasella* is very striking, and the more I look at the creature the more puzzled I seem as to its affinities. We have no European genus at all analogous."]

INDEX.

A

B

E

F

G

N

O

P

ERRATA.

Page 8, in the explanation of figure 1, first line, for "and" read "the."
Page 33, in figure 15, for "cloroform" read "chloroform."
Page 50, line 4, add a period after "Cress"
Page 100, last line, strike out comma before "Say."
Page 103, line 9, for "*Caryæ*" read "*caryæ.*"

SIXTH ANNUAL REPORT

ON THE

NOXIOUS, BENEFICIAL,

AND OTHER

INSECTS,

OF THE

STATE OF MISSOURI,

MADE TO THE STATE BOARD OF AGRICULTURE, PURSUANT TO AN APPROPRIATION FOR THIS PURPOSE FROM THE LEGISLATURE OF THE STATE.

BY CHARLES V. RILEY,

State Entomologist.

JEFFERSON CITY:
REGAN & CARTER, STATE PRINTERS.
1874.

TABLE OF CONTENTS.

PREFACE.

To the President and Members of the Missouri State Board of Agriculture:

GENTLEMEN: According to custom, I herewith submit to you my Sixth Annual Report on the Noxious, Beneficial and other Insects of the State of Missouri. The MS. is yet incomplete, but will be in readiness by the time the printer needs it.

The year 1873 has been characterized by a very short fruit crop, owing more to late cold and wet spring weather than to any other cause; and by other peculiarities which I need not mention, as they will doubtless be set forth in the report of your Corresponding Secretary. Owing to the increasing correspondence of this office, and the increased demand on my time for lectures and essays before State and local societies, I have found it impossible to perform the same amount of field work that I have been able to accomplish in previous years. In fact the duties of the office have become so multipled, that one person can no longer perform them, as they should be performed, with any degree of satisfaction to himself. As the duties of the office increase, so do the expenses, and this has been especially the case during the year about to close, because of the strict regulations adopted by our railroad corporations which have, with few exceptions, made it impossible to obtain railroad passes. Unless, therefore, the means are provided to enable me to employ such assistance as will relieve me of some of the necessary routine and detail, it is very evident that my own time will be frittered away in such details; and when I can no longer make the office as efficient and useful as I desire, I shall be under the necessity of severing my connection with it.

There is another subject to which I desire to call your attention. The law provides that the Entomological Report be bound in with the Report of your Corresponding Secretary. The consequence is that my Report, after it is printed, must sometimes lie for months in Jefferson City before being distributed. The last Report of your Secre-

tary was not published till the end of July, and with the exception of the few copies of the Entomological Report which I have bound separately for my own use, none were to be had till the season was over in which much of the information contained in it might have been used. Again, requests are being constantly made of your Secretary and of myself, for copies of the Entomological Report, by parties who would like to have it separate, and who do not care to pay the postage on the combined volume, which is often very bulky and unwieldy. I would therefore suggest that some effort be made to have the law so altered that the Entomological Report may be bound and distributed separately; and from conversation had with Senators and Representatives on the subject, I think that the suggestion will meet with approval in the Legislature, as I know it will from the people in the State most interested in the Reports.

I have again devoted considerable space to the Grape Phylloxera, an insect which continues to attract much attention both at home and abroad; and it pleases me to know that the Minister of Agriculture and Commerce of France has seen fit to honor your Board, through me, with a grand gold medal in appreciation of what little service it has been my privilege to render to French grape-culture through the studies of this insect recorded in these Reports.

In this, as in the previous volumes, when the insects treated of are new, or the existing descriptions of them are imperfect, or in a foreign language, or in works out of print and difficult of access, I have added a full description, which is, however, always printed in smaller type, so that it can be skipped by the non-interested reader. The popular name of each insect is accompanied by the scientific name, and the latter is generally printed in *italics* and mostly in parenthesis, so that it may be skipped by the practical man without interfering with the text. The Order and Family to which each insect belongs, are also given under each heading. The dimensions are expressed in inches and the fractional parts of an inch, and the sign ♂ wherever used, is an abbreviation for the word "male," and the sign ♀ for "female," and the sign ☿ for neuter.

Many of the figures are enlarged, but the natural size of each of such is also given or indicated by a hair-line, except in the representation of enlarged structural details, where they are connected with the life-sized insect to which they belong.

The name of the author of the species, and not of the genus, is given as authority; and in order to indicate whether or not the insect was originally described under the generic name which it bears, I have adopted the following plan: When the specific name is coupled with the generic name under which it was first published, the de-

scriber's name is attached without a comma—thus indicating the authorship of the dual name: e. g. *Phycita nebulo* Walsh. But when a different generic name is employed than that under which the insect was first described, the authorship is enclosed in parenthesis, thus—*Acrobasis nebulo* (Walsh); except where the whole name is already in parenthesis, when a comma will be used for the same purpose: e. g., (*Acrobasis nebulo*, Walsh).

All the illustrations, unless otherwise stated, are drawn by myself from nature. Figs. 9 and 10 are, however, copied from Westwood.

I again cheerfully acknowledge my indebtedness to Mr. Otto Lugger and Miss M. E. Murtfeldt for assistance in my office work.

My old office, on the corner of Fifth and Olive Sts., no longer furnishing sufficient accommodations, I have secured pleasant quarters at Room 42, St. Louis Insurance Building, N. W. Corner of Sixth and Locust Sts., where all communications should be sent.

Respectfully yours,

CHAS. V. RILEY,

State Entomologist.

St. Louis, Mo., *December* 2, 1874.

NOXIOUS INSECTS

NOTES OF THE YEAR.

[Under this head I here continue the brief notes and observations of the year on such insects as have been already treated of—observations not recorded in the previous reports, to which they are supplementary.]

THE CODLING MOTH.

The first larvæ were obtained under bands, in 1873, on the 23d of June. The first moths were noticed on the 8th of July.

In most parts of the State the apple crop was, compared with the average yield, a failure. The trees were profuse with blossom, but the late cold, wet weather caused the young apples either to fail to set or to wither and fall soon after setting. With a short supply to work on, the effects of the Codling Moth were all the more apparent, where no means were taken to prevent them, though the insect was less numerous than usual. What with its injuries and those of the Plum Curculio, which, for almost total lack of stone fruit, worked more than usual upon pip fruit, the few apples harvested were of inferior quality.

Respecting the kind of bandage best to use, last summer's experience confirms that given a year ago.

The leading article in Dr. LeBaron's Report for 1873, as State Entomologist of Illinois, is upon this insect. In said article are detailed a number of interesting experiments and observations which fully corroborate what was already on record of the insect. It is well known that a certain proportion of infested apples remain on the tree after the worm has left them. The proportion will depend very much on the variety of apple, and on the time of year that the worm ma-

tures: whether, in other words, the worm belongs to the first or second broods. Careful notes, covering such contingencies, are very necessary to any just estimate of how many worms leave the fruit by means of a web or by crawling down the trunk during night, before said fruit falls; and it is doubtful whether any broad generalizations on the subject can be made. Dr. LeBaron estimates that about half the worms thus leave. Hence all systems confined to destroying the fallen fruit are but half-ways toward complete destruction of the worms, and do not compare well, in efficiency, with the bandage remedies. In pear culture they would be of still less value. The result of Mr. Parker Earle's large experience in growing this fruit at South Pass, Ills., in respect of this insect is: 1st. That infested pears hang on the tree after the exit of the worm. 2d. That though they always show the frass before said exit, they do not readily drop from the tree when jarred. 3d. That they are mostly injured by the second brood of worms.

Dr. LeBaron's experience with the Wier trap is similar to my own. Respecting the time to apply, and method of using the bandages, his advice is essentially that which I have given, but preferable in that it points out the least possible labor necessary. He recommends (for N. Illinois) that the bandages be in place a month after the blooming of the trees; that the first examination be made seven weeks after the blossoms have fallen; that three subsequent examinations be made, at intervals of twelve days, and one final one at the end of the season. The soundness of the advice will appear by the light of the facts recorded in previous reports respecting the time required for the complete development of individuals of the different broods; and to make it apply to the latitude of St. Louis, I would say: let the first examination be made not later than *six* weeks after the falling of the blossoms; and that *four* subsequent examinations, at intervals of twelve days, be made between it and the final one in the fall, which may be deferred till all the apples are gathered.

Another point brought out by Dr. LeBaron is the fact, which I can corroborate, that though two worms may often be found in the same apple, they are generally, if not always, of different size; thus strongly indicating that they are from different parents, and that the same moth in a state of nature never lays more than one egg on each apple, though the rule does not hold good in a state of confinement.*

The insect is spreading over the western country which has hitherto been blessed by its absence, and is now working in the orchards of Utah, which had, up to within a year or so, enjoyed immunity from its attacks.

*See 3d Rep., p. 102.

THE COLORADO POTATO BEETLE.

This insect has continued its ravages, but no longer inspires our well-informed farmers with the dread it was wont to. The remedy for its injuries is so very generally known, and so practicable and certain of good results, if properly applied, that the presence of the pest in our midst has lost its threatening character. Yet a great many persons in the States to the north of us must either have become discouraged, or have failed in the cultivation of potatoes, which have reached as high as $2.00 per bushel (wholesale) in the St. Louis market. Indeed, the present scarcity and consequent high price of potatoes, all over the country, has very generally been attributed to the fact that the beetle discouraged so many from planting. There was a time, and that but a few years since, when the potato was one of the cheapest and surest products of the farm, and furnished not only the most wholesome and palatable article of human food, but entered largely into the feed of all kinds of stock. At the ordinary restaurant, one could always depend on a good mealy potato, if nothing else invited to satisfy hunger. To-day the rot, and more especially the Colorado Potato-beetle, not to mention other enemies, have made it one of the most precarious of crops, as well as one of the most expensive to raise. It is no longer fed to stock, and many a family was this winter deprived of its use, as a luxury that could not be afforded. Under the attacks of its numerous enemies, animal and vegetal, it has also degenerated, and instead of the mealy deliciousness of former years, it presents too often a soggy, watery and unwholesome appearance at the table. This state of things may, doubtless, in a great measure be remedied by cultivating the newer and more vigorous seedlings, and by more care in mastering our coleopterous immigrant from Colorado.

NEW FOOD PLANTS.

Mr. Henry Gillman, of Detroit, Michigan, adds to the list of its food plants, several new species on which, in one state or another, he found it feeding.* I quote the following from a letter in which he recounted to me these observations, with the remark that the fact of finding the eggs on a plant, or the insect sparingly nibbling the same, does not prove that it could live and thrive on such plant, as a species, any more than the fact that a cow at times partakes sparingly of animal food proves that she could sustain life on a flesh diet. Yet the facts communicated by Mr. Gillman are interesting, as showing the ten-

*Am. Naturalist VII., p. 430.

dency to which I have before alluded, toward a change of habit from year to year, as the insect changes and extends its habitat:

I found the *Doryphora* 10-*lineata* Say, at Port Austin, Michigan, on June 19, 1872, feeding sparingly on young grass (too immature to determine its species), on which the insect had deposited its eggs. This was generally, though not always, in potato fields or their vicinity. On July 20 (about a month later) I found the insect at Fort Gratiot, Michigan, in large numbers, both larva and perfect states, in the vicinity of potato fields which it had almost destroyed, devouring the younger leaves and flower-buds of the common thistle (*Cirsium lanceolatum* Scop.), which it was rapidly stripping. In the same neighborhood I saw it on Pigweed (*Amarantus retroflexus* L.), Hedge mustard (*Sisimbrium officinale* Scop.), the cultivated Oat, Smartweed (*Poligonum hydropiper* L), and the Red Currant and Tomato of the gardens, as well as the common Nightshade (*Solanum nigrum* L); of which, with the exception of the Nightshade, its more legitimate food, it ate only the young leaves, and of them very sparingly. Two or three weeks later I found the thistles devoured by it even to the thick stems, so that all the leaves were stripped off, and the entire tops of the plants hung down, almost severed. About the same time I saw the insect feeding on the maple-leaved Goosefoot (*Chenopodium hybridum* L), Lamb's quarter (*C. album* L.), and Thoroughwort (*Eupatorium perfoliatum* L.), and on August 8, 1872, I found it, in both the larva and perfect states, voraciously eating the Black Henbane (*Hyosciamus niger* L.), on which was also to be seen an abundance of the eggs. As the last mentioned plant is not native, having been introduced from Europe, the beetle's fondness for it is more noteworthy.

This growing ability to adapt itself to a greater variety of food-plants will render its extermination and control all the more difficult.

Several instances came under my notice where the beetles, in early spring, entered hot-beds in great numbers and devoured tender tomato and egg-plants.

ITS PROGRESS EASTWARD

Has continued during the year, and the *avant couriers* of the vast army have pushed to the extreme eastern limit of New York* and into the District of Columbia.† Mr. M. B. Bateham describes, in the *Ohio Farmer*, how the waters along the shore of Lake Erie, in the extreme N.E. corner of Ohio, were literally swarming with them; and the Painesville (Ohio) *Telegraph* thus chronicles the passage over that town of "clouds of Colorado Potato bugs, bound toward the setting sun"—these "clouds," however, as I have been informed on good authority, not being so dense that more than a few dozen could be seen at any one time by a single person:

* A correspondent (T. L. S.) of the *Country Gentleman* found it around Delhi, in Delaware Co., in the S. E. part of New York; the specimens being pronounced genuine by the editor of that journal to whom they were sent.

† See monthly Rep. Dep. Agr. for Aug. and Sept., 1873.

At first they were supposed to be a swarm of bees, but some of them falling to the ground, the real character was speedily determined. The introductory legion was followed by another, and a third, and a fourth, and so on for an hour and a half, much to the astonishment of all beholders. They were estimated at tens of thousands, and the scene suggested to Bible-readers, locusts and the ancient days. Why these evidently demoralized *Doryphoras* chose to reverse the previous order of their advance, to take the back-track in fact, was beyond the ability of the most erudite Painesvillian to declare. Perhaps they disliked the atmosphere as they approached Washington—a city which even in the decenter days of De Tocqueville was so foul that, according to that writer, the very crows held their noses as they flew over it. But—as our Atlantic friends will regret to learn—all the devastators did not "go West." Enough and to spare are left for seed, and even now—judging from the numerous letters recently at hand—the farmers of the Buckeye State, and even of Pennsylvania, are vexed and perplexed by the 10-lined enemy of the farinaceous tuber. Let New Jersey and Down-East seek solace while they can in the prolific *Solanum*, for the day comes when they too will have sore need of patience and Paris green.

Mr. Townend Glover* reports it in "Garland" (Craighead?) Co., Arkansas; in Marion, Brooke and Tyler counties, W. Virginia, and in Anderson and Livingston counties, Kentucky; but as his correspondents and informants failed to send him specimens, the reports can not be relied on.

PARIS GREEN.

Improved methods of applying this substance have been devised during the year, and it is now very generally used in liquid suspension, in proportion of one tablespoonful of pure green to a bucketful of water, and sprinkled over the vines with a sprinkler or an old broom. A Mr. Cross of Ripon, Wis., has patented an instrument for blowing the spray on any desired part of a plant, intended to obviate the waste of material which follows ordinary sprinkling; but I have not seen the instrument. The liquid has the advantage over the powder in that there is less danger from injury in its use, and that it can be effectually used at any time of day; while the powder can be employed to advantage only while the dew is on the plants. It has, however, some disadvantages: 1st, the green is not soluble, for though it quickly gives a green tint to the water, when stirred, it soon settles to the bottom, unless kept in suspense by continued stirring or agitation; 2d, it settles in spots on the leaves, the natural tendency of the water in finding its level, being to carry and concentrate it wherever a drop finds rest and evaporates; 3d, too much is wasted on the ground in the sprinkling. I have, therefore, found it much more convenient, on a small scale, to use the powder, where it can be obtained ready-

* Monthly Rep. Dep. Agr. Nov.—Dec., 1873.

mixed by machinery. Applied when the dew is on the plants, it will adhere more uniformly, and it obviates the necessity of carrying about so much water.

But whether the green be used in water or as a powder, the flour will prove a desirable addition, since it renders the green more adhesive, and consequently more serviceable; some care will be required in using, however, to prevent its forming lumps. This adhesive quality in the liquid may also be obtained by dissolving dextrine or gum-arabic in the water—both, however, much more expensive than the flour.

Reports from those who have used the remedy for the Cotton-worm, put the cost of material at from 68c to $1.00 per acre for each application.

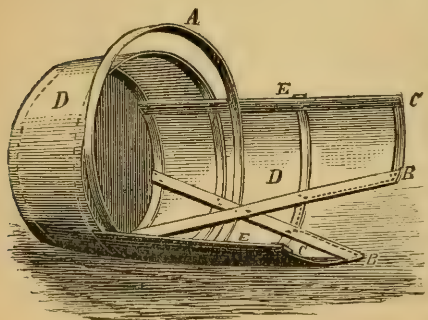
H. Vorhees, of Ottawa Co., Mich., sends the following sensible words to the *N. Y. Tribune*, regarding the use of this remedy:

> Eastern farmers could be much benefited by taking note of our experience with the Potato bug. I see now how I might have made much money by using the experience of farmers further West, where the bugs first made their appearance; for the price of potatoes has more than doubled. I find the cost and applying of Paris green is not more than $5 an acre. It is a sure remedy. Yet there are people here who spend abont 50 days' work on each acre in picking bugs by hand, and in sweeping them in a tin pan with a wisp-broom.

MECHANICAL MEANS OF DESTROYING.

Mr. H. Bowen, of Sheridan, Illinois, thus describes an instrument which he has used with ease and profit. It is not patented, and commends itself for lightness and simplicity:

[Fig. 1.]



POTATO-BEETLE CATCHER.

> Take four wooden barrel hoops, D D, and two narrow barrel staves, two and a half inches wide, B B, and two more, EE. For the handle use a hoop of sufficient length to be handy for the person that uses it, open it and fasten it to the third hoop. All these pieces are to be nailed together with small wrought clinch nails. When this is done it will be nearly in the form of a barrel, or something like a flour-scoop. The frame work is to be covered by sewing on cotton cloth, except at one end and part of the top.
>
> To work it, it is held in one hand and the mouth is slipped around the hill of potatoes close to the ground. With the other hand, the vines are struck a light blow with a *new* broom, and all the bugs are jarred into the cage. After a quantity has been "bagged" they are

emptied out and destroyed. I caught bushels of them last summer, with but a small amount of labor.

I am indebted to the publishers of the *Prairie Farmer* for the illustration, which first appeared in that journal.

PREPARING FOR IT IN EUROPE.

In December, 1872, Col. Fred. Hecker, of Summerfield, Illinois, the well-known and enthusiastic political agitator and tribune, sent to the *Gartenlaube* (Heft 3, 1873,) an article on this insect. The article was a condensation, and in some parts a literal translation from these Reports, my figures being copied to illustrate it. It has since been retranslated and the illustrations recopied (and accuracy is not apt to increase with these processes, and certainly has not in these instances) for several English journals, over the signature "*Fr. H., State of Illinois;*" and since the original translator didn't think it worth while to indicate the source from which he drew either his information or illustration, it is not surprising that the *Gartenlaube* is left without credit in the retranslations. It is surprising, however, that solid journals, like *Hardwicke's Science Gossip* and *The London Gardeners' Chronicle*, should have been so easily led into the consideration of such myths as "*Cantharis viniaria*," "*Doryphora decem-punctata*," etc. Some of the articles in the English periodicals on this "new enemy of the potato" close with the advice that "in the importation of seed of American potatoes, which is now carried on to a very large extent, the utmost caution should be exercised to prevent the introduction of the beetle to this country."

Indeed, Mr. J. Algernon Clarke, Secretary of the Central Chamber of Agriculture, on the 10th of February addressed a letter to Mr. Gladstone, calling his attention to the imminent risk to which the United Kingdom, especially Ireland, is exposed, and went so far as to suggest that the importation of potatoes from the United States and British America should at once be prohibited.

In 1871, speaking of the eastward march of this insect, I wrote as follows: "Indeed, it is quite possible that even the broad Atlantic may not stay its course; but that when once the beetles swarm in the streets of New York as they did in those of St. Louis last spring, some female, loaded with fertile eggs, and hidden in the nooks and crannies of some vessel, may be safely borne over to the land of 'murphies,' where she might easily found a colony which would soon spread consternation into other potato-growing countries to the eastward. In giving, through Sir Walter Raleigh, the precious tuber to Europe, America conferred upon the Old World an everlasting boon. She

may yet unwittingly be the means of bequeathing as great a bane, by sending across the ocean the deadliest enemy of that tuber! At all events, it behooves our European neighbors to be on the look-out, and to prevent, if possible, any such catastrophe."

That there will be danger of the insect finding its way to Europe, when once it reaches the Atlantic sea-board, no one can doubt; for the impregnated females will live for weeks, and even months, without food, especially in the spring and autumn, when they also take most readily to wing. Such females, alighting on outward-bound vessels, may easily be given free passage to European ports, and as they will be apt to land without passports, it would be well for the authorities to look out for and prevent such unwelcome incursions. I do not think that there is danger of its being carried across the ocean in any other way, for potato plants, on which the eggs or larvæ might be carried, are not articles of commercial exchange, and seed potatoes do not, as a rule, harbor the beetles. Let our European friends profit by our sad experience with this insect, and, taking time by the fore-lock, endeavor to prevent its introduction into their potato-fields. This end will best be accomplished through the agricultural and horticultural societies, which should make provision for the dissemination of correct information concerning the pest. A small card, giving a colored figure of the beetle, or of all stages of the insect, setting forth the disasters which would follow its introduction, and appealing to the reader to assist in preventing such a calamity, would do good service if posted in the cabins of vessels plying between the two countries, in the warehouses and seed-stores of sea-port towns, and in the meeting rooms of agricultural societies. Some such simple means of familiarizing the public with a possible enemy should be adopted in a country like Ireland, which will, perhaps, be the first to receive the pest, and would suffer most from it.

In Prussia the government has adopted a system of agricultural teaching which other countries might well pattern by. Traveling teachers (Wanderlehrer) are appointed, one to each district (Kreis) of twenty or thirty square miles, whose duty it is to call the farmers together in their meeting-houses, lay before them recent important facts in agronomy, institute experiments and implement trials, etc., etc. With such a system the agricultural community can easily be made aware of possible danger, and a large bottleful of our Ten-striped potato-beetles, which a St. Louis friend of mine took over there a year ago, did good service, in that the beetles were distributed, as exhibition specimens, to some of these traveling teachers.

THE COTTON WORM.

The growing of cotton is getting to be an important industry in some of the southern counties of the State, and a few notes on the Cotton-worm (*Anomys xylina*) will doubtless prove acceptable to many a Missourian, as well as to such residents of the more southern States into whose hands this Report may chance to fall.

In June, 1872, at the organization, in St. Louis, of the National Agricultural Congress, there were present many delegates from the South. It was my privilege on that occasion to lecture before the Congress on economic entomology, and to suggest, in answer to inquiries from Gen. Wm. H. Jackson, of Nashville, Tenn., and Dr. J. O. Wharton, of Terry, Miss., that the Paris green mixture which was doing such good work in preserving our potato fields against the attacks of the Colorado Potato-beetle, might prove equally efficient against the ravages of the insect which takes the place of this potato enemy in the cotton fields of the country. Having no opportunity to experiment on the Cotton-worm, I tried the effect of the mixture on several closely allied worms which occur in Missouri, and especially on the Fall Army-worm (Rep. 3, Fig. 45,) in each case with most satisfactory results. Feeling thus well assured that the remedy would work beneficially as an antidote to the Cotton-worm, and might prove of untold value to the people of the South, I took occasion to read an essay on that insect at the second annual meeting of the same National Agricultural Congress, which took place at Indianapolis, Ind., the last of May, 1873, and I give herewith some of the prefatory portions of that essay:

Gentlemen of the National Agricultural Congress:

It was my pleasure, well nigh a year ago, to be with you at your organization in the city from which I hail. Few things were more characteristic of that reunion of the friends of Agriculture from different parts of our broad land, than the large representation from the South, and the mutual good-will and cordial fellowship which reigned on all sides. There was manifested a due appreciation of science in the honor paid to one [Com. M. F. Maury] who did much to make us masters of the elements, and whom we all sorrow for as having since left us for that world which knows nor sectional strife nor brotherly feud. There was also manifested a strong desire to profit by one another's experiences, and it is for these reasons that I am led to offer to the members from the South a suggestion which may prove of little service, or, *per contra*, of the utmost value.

I gave you last year some idea of the immense sums which the farmers of this country lose by insect depredations, and it is unnecessary here to enlarge upon the subject. You, as cotton-growers, are well enough aware of these ravages, for in a single fortnight last summer, one single species—the Cotton-worm—ate up something like twenty million dollars' worth of cotton for you.

Some of the Northern States have been sufficiently wise and provident to appoint officers whose duty it is to study these insect pests, and suggest remedies for their ravages; but in the South, no such officers yet exist. You are, in consequence, entirely at the mercy of this apparently insignificant worm; and it is a matter of surprise that, where the losses are so heavy, some efforts have not been made to get the mastery over the pest by delegating some individual or commission to make thorough investigations and experiments upon it. Up to the present time, no really practicable remedy has been discovered. Hand-picking is not wholesale enough. Fires, lights and traps containing attractive but poisonous sweets, together with all other devices, intended to allure and destroy the parent moths, are of little use except where they can be generally employed throughout whole districts—and this implies an amount of intelligence, organization and unity of purpose, rarely, if ever, found in any community. Carbolic soap has failed to fulfil the hopes and prophecies of its advocates. Now, it has never been my fortune to experiment in a cotton field, but from my experience with insecticides in other fields, I feel quite assured that by a proper use of Paris green, the Cotton-worm may be mastered.

In the so-called Northwestern States, as you are doubtless aware, we have been sorely troubled, during the past decade, by the Colorado Potato-beetle (*Doryphora 10-lineata*,) an insect which affects the potato very much in the same way as the Cotton-worm affects the cotton plant; but from which it is not likely that you of the South will ever suffer. We manage to subdue and defy it by a proper use of the mineral mentioned, and from my experiments upon other leaf-devouring worms, many of them belonging to the same family as your Cotton-worm, I am satisfied that this last will succumb to the mixture I propose, even more readily than does the Potato-beetle. * * * Believing firmly that in this mixture we have a cheap and available antidote to the Cotton-worm plague, I am anxious to give the suggestion as wide a circulation as possible, in order that it may be thoroughly tried and reported on the coming summer.

This means of appealing to the cotton-growers of the country had the desired effect. The essay, giving directions for the proper use of the poison, together with the natural history of the worm, was published, either entire or in abstract, in a large number of the agricultural journals which circulate in the South. The remedy was, in consequence, very thoroughly tried and generally used, its merits being so fully discussed that I received over a hundred articles on the subject which Mr. C. C. Langdon, editor of the *Rural Alabamian*, kindly clipped for me from his exchanges. Later in the season, when experience had settled many important points as to the effect of Paris green on the Cotton-worm and the best mode of using it, the Department of Agriculture sent out a circular to its cotton-growing correspondents; which circular, with numerous answers, many of which are so indefinite in point of detail, as to be of no value, or to convey wrong impressions, and all of which lack signature and date, was published in the monthly Department Report for November and December, 1873. The general

conclusions which Mr. Glover deduces from them correspond, however, not only to the mass of testimony elicited by my own correspondence, and found in the clippings sent by Mr. Langdon, but to the experience had of this insecticide in the more northern States, as already detailed in these pages. I give these conclusions in Mr. Glover's own words:

Of the seventy returns reporting actual experiment, a large proportion, at least four-fifths of all, declare the success, either full or partial, of the application of mixtures of Paris green or other arsenical compounds, when they are properly applied. Some are content with the simple declaration that it is an effectual remedy. Where it is most generally used it is most approved. In New Iberia, La., where a machine that will powder 15 to 18 acres per day is in use, it is said that fifty planters have found it successful. In Wilkinson, Mississippi, where a simple compound of Paris green and flour was used, "rows treated with the compond were healthy and vigorous, while neglected rows beside them were destroyed." In Landry, Tex., "one application of Paris green in solution resulted in ten additional bales in a field of 35 acres, over the rate of production in other fields where none was used." A similar result is reported from Montgomery, Tex., by the use of Paris green mixed with lime or plaster, or even fine sand, where "a neighbor has picked already ten bales of 500 pounds each from 13 acres, while freedmen on the same farm lost their whole crop by refusing to use it." The correspondent in Worth county, Ga., declares it "was death to everything that eats the leaves that have been sprinkled." Some correspondents enjoin the necessity of repeated applications to meet the appearance of successive broods of worms, as enough are left after the most careful application to perpetuate the noxious race. In some cases, caution is suggested not to make the application after the bolls are open, lest it become "dangerous to picker and ginner." In the cases of failure mentioned there appears no evidence that the application was properly and persistently made, and with a pure article of Paris green. In some cases where it killed both worms and plants, it is very evident that the proportion of Paris green was too large or applied too heavily." * * * * *

It has, in short, proved most satisfactory, wherever properly and intelligently used.

The following item will give an idea of what it costs to use this remedy on a large scale. Mr. J. R. Maxwell, of Alabama, writes to the *Southern Farmer:* "I have been successful in the use of Paris green on the Cotton-worm. I had one hundred acres of cotton on swamp land that would have been ruined, but on their first appearance I commenced on them. I put eight hands on mules, with two-gallon watering pots, and had ten more hands and two wagons engaged in keeping them supplied with water and poison, and went over my cotton twice; up one side of a row and down the other, going thus twice to each row. Poison, labor and all cost me about three hundred dollars. It has saved me at the very least twenty bales of cotton. I used the poison by putting to each canful of water half a tablespoonful

of poison and three tablespoonfuls of flour; stirring it well. I tried it first without flour, but every shower would wash all the poison off."

Another Alabama farmer writes to the *Southern Cultivator* that he successfully used the powder mixture on fifty acres at a cost of sixty-eight cents per acre. Finally, Mr. D. F. Prout, of Demopolis, Ala., who has, anonymously, lately published a small "Essay on the best mode of using Paris green for the destruction of the Cotton-caterpillar," says that the cost of material, per acre, for two applications will not exceed $1.75, viz.: 40 pounds of flour at 2½ cents per pound, and 2 pounds Paris green at 37½ cents. He found, in his own experience, that an expenditure of $100 on about 80 acres increased the crop at least 10 bales.

A machine to facilitate the sprinkling of the mixture on a large scale has just been patented (Dec. 16, 1873) by the Hon. J. W. Johnson, of Columbus, Texas. It consists of a large tank or reservoir, into which the poison is placed, and from which it is lifted by a double-action force pump into two branches of a pipe on top of the tank, which connects with a horizontal tube running transversely across the rear of the tank. To this tube are connected shorter adjustable nozzles, and the flow of liquid is easily governed by a suitable valve in the pipe. The pump is worked by a lever pivoted to one of the two wheels, which are small and attached to the tank by means of vertical bars, so as to enable the machine to pass over the plants without injury.

Other devices have been contrived to facilitate sprinkling; and Mr. W. P. Reese informs me that one costing only $10.00 was used quite extensively around Selma, Ala.

The remarks (*ante* p. 14) as to using the green in liquid or powder need not be repeated. This remedy will, from the different habits of the insect, not prove of any great value against the Boll-worm. Its use should be abandoned, except for extreme reasons, after the bolls open, so as to prevent any injury that might follow the ginning of the poisoned cotton.

PATENTS ON THE PARIS GREEN MIXTURE.

Although aware of the fact that sundry patents had been taken out by persons in the more northern States* for Paris green in combi-

* The Commissioner of Agriculture, in a letter to Prout and Robertson, of Demopolis, Ala., writes (July 23, 1873:) "There are three patents already taken out for the use of Paris green, in *combination* with other ingredients, for the destruction of injurious insects. In 1868 James P. Wilson, of Illinois, took out a patent (No. 82,468) for one part of Paris green and two of mineral paint, to be used to kill potato-bugs. Lemuel Pagin, of Niles, Michigan, (patent No. 112,732) claims a combination of fine flour and middlings with Paris green and resin, to kill potato-bugs; and Green F. Whisenant, of Chapel Hill, Texas, (No. 134,959) for destroying caterpillars on cotton."

nation with other ingredients, to kill potato beetles, I was not aware that anything of the sort had been done in the South till I received the following letter, accompanied by several circulars, containing references, etc.:

PROF. C. V. RILEY, *State Entomologist, Mo.—Dear Sir:*

My attention has been called to a paper read by you at Indianapolis, in reference to the destruction of the Cotton-worm with the use of Paris green. I have experimented with the Paris green. I combine it with cheap flour and other ingredients to make it stick to the leaf, so the rain does not wash it off. My compound is under patent. It is used in the West to destroy the potato-bug and in the South to destroy the worm. I am having it introduced into all the cotton States. It is an effectual preventive against the ravages of the Cotton-worm—does not injure the plant and does not wash off.

Inclosed please find circulars.

Very respectfully, yours, etc.,
WM. B. ROYALL.

BRENHAM, TEXAS, July 2, 1873.

The patent is numbered 112,732, and the following advertisement, which I found a short time afterwards, in several Southern journals, will explain the ingredients which this right royal mixture contains:

NOTICE.—The ingredients of my "Cotton Worm Destroyer" and "Potato Bug Destroyer," are as follows: "Paris Green," "Flour of Elm or Gum Arabic," "Common Flour," "Powdered Rosin." These remedies are covered by my Letters Patent for all of the Cotton-growing States. Any person using any of these ingredients without authority from me, or my agents, will be prosecuted in the Federal Courts; and the full penalty of the United States Patent Laws visited upon those thus infringing upon my Patent.

W. B. ROYALL.

BRENHAM, TEXAS, July 15, 1873.

It is to be regretted that patents can be obtained at all for remedies of this nature after they have become generally known and rightfully belong to the public. When the discoverer of such a remedy does not see fit to patent it, no one subsequently has a moral right to whatever speculative right he may possess. Fortunately, in this case, the patentees can not interfere with the public rights, and it is to be hoped that no planter, either of potatoes or cotton, will be induced by flaming circulars and threats, to pay even one cent per one thousand acres, much less the demanded $20.00 per one hundred acres, for the privilege of using these patented mixtures. The very fact that so many patents have been granted for the same purpose, all of them having Paris green as a base, shows clearly that the patent covers only the particular combination. By ringing the changes on the different proportions of the several ingredients, a thousand of these patent remedies may be obtained; and any one who diverges but a

fraction from the particular patented combination, ceases to infringe upon it. It will therefore be utterly impossible for the patentees to enforce the penalty for infringement without proof that precisely the same ingredients and combination, as patented, were used; and to get such proof will, I take it, be no easy matter; for were it, we should hear of hundreds of thousands of prosecutions where now we hear not of a single one.

The Royall mixture is a good one, and it seems to me that the Messrs. Royall & Son could do a very good business by preparing and putting it on the market at a reasonable profit, without attempting to obtain besides a royalty for its use. In a circular lately issued, any number of testimonials as to the satisfaction it has given are produced; and Mr. Royall tells us that "a machine has been invented (which it is hoped will be in readiness by the time the next worm season comes) by means of which the remedy can be applied to three rows at a time and upon about twenty-five acres per day. It is worked by two horses and one hand, (the driver,) with a seat upon the vehicle, and with the axle curved so as not to injure the plant of the middle row in passing over. It can be attached to the hind wheels of any ordinary wagon, thus reducing the cost of same." Also, that "It takes from fifteen to twenty pounds of mixed material to an acre of cotton from four to five feet high, for the first application. For the second application upon the new growth, about one-third only of this quantity is required."

HIBERNATION OF THE INSECT.

The question as to whether the Cotton-worm hibernates as a moth or as a chrysalis has again been very fully discussed *pro* and *con*; and it does not speak well for entomological knowledge in the South that this important feature in the life-history of so notorious an insect has not long since been very definitely and irrefutably settled. In my second Report I showed that analogy, as well as the evidence of the more reliable observers, indicated that the winter was passed in the moth state; and such I still firmly believe to be the case. Mr. W. P. Reese, of Selma, Ala., both by letter to myself, and in numerous published articles, has strenuously argued that it is passed in the chrysalis state; upon which argument he basis a pet preventive remedy, which is to destroy these chrysalides in the winter time. Mr. Reese falls into the error—committed by so many when first they begin the study of natural history—of too readily generalizing from isolated facts. Certain moths which he bred having died in confinement within seventy-two hours after leaving the chrysalis, *ergo* the life of the moth is limited to that period, *ergo* it can not pass the winter.

Such is Mr. Reese's most unsafe reasoning, which he will very soon change, with increased experience. The first brood of Codling-moth larvæ seldom live more than a month as such, though those of the second brood may and do live six and seven; and I need hardly say that by the same style of reasoning which Mr. Reese adopts, one could easily make out that no insect which produces more than one generation a year could hibernate at all.

NATURAL ENEMIES.

The Cotton-worm must have numerous enemies among its own class, but nothing seems to have been recorded of such. Black-birds and turkeys are said, by correspondents of the Department of Agriculture, to greedily devour the worms, and it has been recommended to introduce the English sparrow into the southern cotton-fields for this purpose. This bird will doubtless do better there than in the more northern States. Some that were liberated in Lafayette park, St. Louis, a year ago, have done remarkably well, and have already usurped the place of some of the native birds at the Arsenal.

RANGE OF THE INSECT—OTHER QUESTIONS.

The Cotton-worm is generally supposed to be a purely Southern species, and to be confined to the cotton plant for food; yet the moth has been repeatedly captured as far north as Chicago, both by Mr. A. Bolter and Mr. O. S. Westcott; and the indication is very strong that those moths were bred there, and that their larvæ fed on some other plant than cotton. These facts would also seem to invalidate a theory propounded by Mr. Glover, of the Department of Agriculture, to account for the "general prevalence of the insect on the Gulf coast, and its comparative scarcity and late appearance in more northern regions." He thinks "that in the more northern portion of the cotton-belt the frosts of winter destroy the insect in all its stages, unless in situations of unusual protection, but that in the more southern portion, where severe frosts rarely occur, they survive the risks of winter, and as they increase, by their repeated generations during the summer, they migrate northward in the fly-state (the perfect insect) to 'fresh fields and pastures new.'"

If the insect can withstand a Chicago winter, it would not likely be frozen to death even in the northernmost portion of the cotton-belt. Indeed, hibernating insects, when once in a state of dormancy, generally resist very severe cold; and it strikes me that the longer seasons, enabling the production of a greater number of annual generations, on the Gulf coast, is sufficient to account for the facts above stated; especially as there are no records of migrations of cotton

moths, and no insect migrates to any great distance except in large swarms or bevies.

In my former article on this insect I stated, on the authority of the late Mr. Thos. Affleck, of Brenham, Texas, that the Cotton-moth always alights head downward. Dr. D. L. Phares, of Woodville, Miss., who is also a good observer, can not subscribe to this statement, as the following quotation from one of his letters will show: "It is to me and others unaccountable that the late Mr. Affleck (long resident in Adams county, Miss., and having a farm in this, Wilkinson county,) should, so late as 1868, reiterate that the *Anomis* invariably alights with the head down, or instantly assumes that position, for it does not accord with my observations this or any former year."

THE CANKER-WORM.

In his second annual Report, as State Entomologist of Illinois, Dr. William Le Baron gives prominence to an article on this insect, detailing much interesting experience had with it in 1871, and publishing for the first time some important facts. This experience accords with and confirms what I have already written so far as it goes.. He shows that the moths are most active in the evening: *i. e.*, they are crepuscular, like almost all the species belonging to the same family. He also shows that the principal mode of migration is by the worms floating in the air and being blown from tree to tree while hanging from their threads. I subjoin his summary of remedies in his own words:

"1st. Prevent the passage of the moths up the trees. The most approved plan heretofore used is to put a canvas or other cloth band, six inches or more in width, around the trunk and besmear it with tar, or a mixture of tar and molasses, applied every other day. The method suggested in this report is to put a band of rope or closely twisted hay around the trunk, and over this a tin band about four inches wide, placed so that the rope shall be at the middle of the tin, making a closed cavity below, and a free edge of tin above. The time to use these appliances is mostly in the month of March, but also at other times when the weather is sufficiently open to permit the insects to run.

"2nd. If the moths are prevented from ascending the tree, they will deposit their eggs below the obstruction, and for the most part near to it. These eggs can be destroyed by a single application of kerosene oil.

"3d. If the moths are not prevented from ascending the tree they will deposit their eggs mostly upon the under side of the scales of bark, on the upper part of the trunk and larger branches. Many of these can be destroyed by scraping off and burning the scales.

"4th. If all precautions have been neglected and the eggs have been permitted to hatch, then, as soon as the worms are large enough to be easily seen, jar them from the trees and sweep them away with a pole, as they hang by their threads, and burn or otherwise destroy them.

"5th. If the worms have matured and gone into the ground for winter quarters, plow the ground late in the fall, so as to expose the pupæ to frost, and to the action of natural enemies.

"We wish to call particular attention to the rope and tin bands mentioned in the first paragraph. We have found this, upon the few trees to which we have applied it, an almost perfect barrier to the ascent of the moths, and we are very desirous that others should give it a trial on a larger scale. The method of putting on these bands is very simple. Take a piece of inch rope—old worn out rope is just as good as new—tack one end to the trunk, two feet or less from the ground, with a shingle nail, driven in so that the head shall not project beyond the level of the rope. Bring the rope round the tree, and let it lap by the beginning an inch or two, cut it off and fasten it in the same manner. Get the tinman to cut up some sheets of tin into strips four inches wide and fasten them together endwise, so that they shall be long enough to go round the trees over the rope band, having the rope at the middle. Let the ends of the tin lap a little, punch a hole through them and fasten them with a nail driven through the tin and rope into the tree.

"The result of this contrivance is that the moths congregate below the obstruction, and sometimes pile up so as to go over onto the tin. But when they reach the upper edge of the tin they go round and round it till they become discouraged. They could easily go down on the inside of the tin and across the rope onto the tree, but so far, at least, as my experience goes, they do not do so. Their instinct impels them to go upward, and these simple, unreasoning creatures do not know enough to overcome the difficulty by first going a little downward. They have not yet learned the art sometimes practiced by females higher in the scale, of stooping to conquer."

Mr. R. M. Milliken gives the following experience with this tin and rope trap, in a late number of the *Prairie Farmer:*

In 1873 I applied the rope and tin in this way: I nailed a rope tight around the tree, took tin five inches wide and nailed it on the rope, half the tin above the rope and half below it. I put it on with three-

penny nails. After I put the tin on, I took lime and sand and made a thin mortar and poured it in on the rope to stop any holes that might be left. When the tin gets full below, they will get on the tin, but won't go down above to get on the tree. I saw them on the tin (that is, the moth,) but did not see one above it. I have known some to try it on a few trees, and condemn it because it was not successful. If the trees don't stand more than two rods apart. the wind will carry plenty of the worms from one tree to another to strip it. My trees stand fully two rods apart, and in 1872 they were one complete mass of webs, made by the wind carrying the worms from one tree to another. My trees measure from two to four feet in circumference, and it did not cost me twelve cents for each tree.

If the trunk is kept clean below the trap, and an application of kerosene made to the eggs from time to time, there will be no necessity for plastering the upper part of the trap. It is more difficult to check the ascent of the young worms than their parents, because of their minute size and power to travel over the smoothest surfaces. The best way to do it is by greasing the eggs and thus preventing their hatching. If the tin is smeared with a mixture of equal parts of kerosene and castor oil, it will prove still more effectual.

The Paris green remedy has been effectually employed to destroy the worms when once they are defoliating trees; but its use should be discouraged, except on tall shade trees, where in an emergency the green in liquid, thrown up by a garden pump, may be of great service. The worms should not be allowed to reach the leaves; and, where they have thus been allowed, it is best on a calm day to strew the ground lightly with straw, give the tree a good jarring—as suggested by Dr. Le Baron—cut loose the suspended worms by means of a pole, and then set fire to the straw. A Canker-worm holocaust will be the result, and with a little care the tree need not be injured.

The following description of a trough, taken from the report of a committee chosen to award a premium of $100, offered, not long since, by the Essex (Mass.) Agricultural Society, for a "new, cheap and effectual remedy against the ravages of the Canker-worm," will prove of value to those who can not conveniently obtain the tin strips above described:

The protector used by Mr. Sawyer is simply a trough or gutter laid upon the ground around the tree, and filled with coal tar from the gas-works. The troughs used by Mr. Sawyer are made of two-by-three joists, sawn from two-inch plank. A channel an inch or more deep and an inch and a-half wide, is grooved out, and the stock is then sawed off in a mitre-box at suitable lengths for different sized trees, and the pieces nailed together, one side slightly, so that it can be easily removed when placed around the tree. A square box or trough is thus made which is laid level on the ground around the tree. The space between trough and tree trunk is filled with dirt, the trough itself filled with coal tar from the gas-works, and the work is done.

A triangular channel will have some advantages over a rectangular groove.

I recollect reading in a number of the *Western Rural* of a very good plan adopted by a Mr. Smith, of Des Moines, Iowa, for applying coal-tar, molasses or other sticky substance. He first makes a slight mound of earth around the tree, smoothing it at top; brown wrapping paper, to be smeared, is then tied around the tree and turned down over the mound. The moisture of the earth prevents too rapid drying of the tar, and the plan proves at the same time a preventive of the Round-headed borer.

Mr. J. W. Robson, in the *Western Farmer* for May, 1871, gave the following testimony as to the birds which destroy this worm:

> The Blue-bird destroys large numbers, not of larvæ alone, but of fully developed moths in the fall, and again in the spring they return just in time to devour the insect as it emerges from the soil.
>
> The Cedar-bird is another enemy. This little bird is a gross feeder, and when the canker-worms appear in great numbers, as they sometimes do, it will come in large flocks and feed upon them day after day till the pest is subdued.
>
> The Butcher-bird also feeds its young largely upon the larvæ. We well remember it clearing two trees literally covered with this caterpillar, and so well did that pair of Shrikes do their work, that these same trees have not been troubled with the insect since.

In the *American Naturalist* (Vol. VIII, p. 271) Dr. Packard quotes Mr. C. J. Maynard, of Ipswich, Mass., who has examined the stomachs of some three thousand birds, as giving the following formidable list of species which devour the Canker-worm:

> In answer to your questions relative to birds eating Canker-worms and the larvæ of other injurious insects, I would say that upon examing my notes, I find that I have taken Canker-worms from the stomachs of the following species:
>
> Red-eyed Vireo (*Vireo olivaceus*), Song-sparrow (*Melospiza melodia*), Chickadee (*Parus atricapillus*), Scarlet Tanager (*Pyranga rubra*), Robin (*Turdus migratorius*), Black-billed Cuckoo (*Coccyzus erythrophthalmus*), Wood Pewee (*Contopus virens*), Least Pewee (*Empidonax minimus*), Wilson's Thrush (*Turdus fuscescens*), Black and White Creepers, Blue Yellow-backed Warbler (*Parula Americana*). Maryland Yellow-throat (*Geothlypis trichas*), Nashville Warbler *Helminthophaga ruficapilla*) Golden-crowned Thrush (*Seiurus aurocapillus*), Chestnut-sided Warbler (*Dendroica Pennsylvanica*), Yellow Warbler (*D. æstiva*), Black-and-yellow Warbler (*D. maculosa*), Prairie Warbler (*D. discolor*), Black-polled Warbler (*D. striata*), Canada Warbler (*Myiodioctes canadensis*), Red-start (*Setophaga ruticilla*), Cedar-bird (*Ampelis cedrorum*), Cat-bird (*Mimus carolinensis*), Purple Finch (*Carpodacus purpureus*), White-winged Crossbill (*Curvirostra leucoptera*), Chipping Sparrow (*Spizella socialis*), Indigo-bird (*Cyanospiza cyanea*), Red-winged Black-bird, (*Agelaius phœniceus*), Crow Black-bird (*Molothrus pecorus*), Bob-o-link (*Dolichonyx oryzivorus*), Baltimore Oriole (*Icterus Baltimore*).

Other correspondents mention the King Bird, Purple Grakle House Pigeon, all the Vireos, Downy Woodpecker, Summer Yellow-bird, Blue-bird, Golden-winged Woodpecker, Golden Robin and Yellow-bill Cuckoo. With such a formidable array of feathered enemies, the sudden disappearance of the Canker-worm, for a term of years, from orchards where it was wont to play havoc, is no longer to be wondered at.

Following Harris, I have stated* that the sexes of this insect may be distinguished in the chrysalis state by the female chrysalis being destitute of wing-sheaths. Mr. B. Pickman Mann has lately shown† that this is a mistake, and that, singular as it may seem, the female chrysalis possesses perfect wing-sheaths, but no wings under them.

Mr. Mann has also published some additional facts regarding this insect‡ which stamp him as an admirable observer, and which add much to a proper understanding of the species.

It results from his observations, which are based on large material, that we have two quite distinct but closely allied species. The species orginally described as *vernata* by Peck, in 1795, is the smaller of the two. It may be easily recognized in the light of Mr. Mann's discriminations, by each of the first seven joints of the abdomen in both sexes bearing two transverse rows of stiff, red, posteriorly directed spines; by the front wings having three transverse, dusky lines, and a somewhat broader, jagged, pale submarginal line; and by the whole body in the female, as also the legs and antennæ, being pubescent with pale and dusky hairs—the abdomen having a medio-dorsal black stripe. The dusky stripes on the front wings, except at costa, and the black stripe on the abdomen, except at each end, are usually more or less obsolete.

The second species is somewhat larger; the front wings of the male have a distinct white spot on the front edge, and are crossed by two pale jagged bands, along the sides of which there are several blackish dots. The hind wings also have a pale curved line, more or less distinct, across their middle. The female is uniformly dark ash-gray above, paler beneath, with the antennæ naked, and the legs and abdomen smooth and glistening. Thus it lacks the characteristic spines of *vernata*, the dusky marks across front wings, and the pubescence in the female; and there are many other minor differences.

Now the curious fact in the past history of these two insects is, that Dr. Harris, in his popular work on the "Insects injurious to Veg-

*2nd Rep. p. 97.

†Proc. Bost. Soc. N. H. XVI., p. 165

‡*Ibid*, XV., pp. 381-4. and pp. 204-8.

etation," by mistake described the second species as the true *vernata* of Peck, and distinguished the real *vernata* by the name of *pometaria*, hesitating as to whether or not it should be considered specifically distinct from the other. Most subsequent authors have followed Harris in his definition of Peck's species, and Mr. Mann himself did so till Mr. H. K. Morrison drew his attention to the original description and pointed out the error. The consequence is that the larger form remains to this day unnamed, but will doubtless be known as *pometaria* Mann, the *pometaria* Harr. being a synonym of *vernata*.

In the article in my second Report I have described the genuine *vernata*, simply because it is the most numerous in my cabinet, and considered, with most previous authors, that the two were but varieties of one species. The figures in the cut (66), accompanying that article, as should have been stated at the time, were not drawn by myself, but were prepared in New York by the publishers of the *Rural New Yorker*, from the figures of Harris and Packard. They are all very poor, though it is evident the male represents the true *vernata* Peck, and the female the *pometaria* Mann, enlarged.

Mr. Mann gives some reasons for believing that *vernata* Peck, true to its name, is purely vernal in habit, and does not issue in the fall, while *pometaria* Mann issues for the most part in the fall of the year—a fact, if future experience establish it, of high, practical importance.

It is well known that in Philadelphia, as in many other eastern cities, the Canker-worm was formerly a great nuisance, not only because of the injury it did to the elms and other shade trees, but because it was continually spinning down on to persons who happened to be passing underneath the infested trees. I noticed when in the Quaker city last fall, an unusual abundance of the gaily colored and hairy larvæ of the White-marked Tussock-moth;* and upon inquiring of my friend Meehan, as to whether they were ordinarily so abundant, I was surprised to learn that they had only increased to such an alarming extent since the introduction of the English sparrow. The idea prevails that in proportion as this bird exterminated the Canker-worm which formerly held such sway, in that proportion the hairy Tussock-moth larva, which is distasteful to the bird, increased, until it has come to be as much of a nuisance as was the looping scourge whose place it has usurped. We are thus brought face to face with another phase of the bird-insect question, and so far as the English sparrow is concerned, the Philadelphians may well ask, in the expressive language of the time: "Does protection protect?"

*1st Rep., Fig. 82.

INSECTS INJURIOUS TO THE GRAPE-VINE.

THE GRAPE PHYLLOXERA—*Phylloxera vastatrix* Planchon.

(Subord. HOMOPTERA; Fam. APHIDIDÆ.)

Having, in my last three reports, had much to say about this insect, and finding that there is great demand for correct information relative to its nature and habits, and that the fourth Report, more especially, is no longer to be obtained, from the fact that the edition is entirely exhausted, I have concluded to bring into the compass of one article all the facts previously published and recently ascertained, so as to give the grape-growing reader a clear insight into all that is known of it at the present time. In doing this I shall relegate all the more minute details to an appendix at the end of the article, to be referred to by passages numbered to correspond to numbers indicated in the text.

"Phylloxera" is a term derived from the Greek (φυλλον and ξηρός), meaning *withering the leaf*, and founded many years ago, * by Boyer de Fonscolombe, to designate a peculiar genus of plant-lice. It was originally erected for a species (*Phylloxera quercus*) quite common in Europe on the under side of oak-leaves which, in consequence of its punctures, wear a withered appearance. The genus now comprises several species, none of them affecting man's interests except the species under consideration (*vastatrix* Planchon). This, on account of its injurious work, has acquired such prominence that the generic term has come to be used in a broader sense, and to indicate at once the insect and the disease it produces: just as in botany the term *Oidium*, though originally referring only to a genus of cryptogamic plants, is now popularly employed to designate the mildew on grapevines, caused by *Oidium Tuckeri*.

BIBLIOGRAPHICAL.

The first published reference to this insect was made in the year 1856,† by Dr. Asa Fitch, the State Entomologist of New York, who subsequently described the gall-inhabiting type of it, which I have termed *gallæcola*, in a rather insufficient manner,‡ by the name of

* *Annales de la Société Entomologique de France, tome* iii., p. 222.

† New York Entomological Reports, vol. i., p. 158.

‡ *Ibid*, vol. iii, § 117.

Pemphigus vitifoliæ. Dr. Fitch knew very little of the insect, as we understand it to-day. It was subsequently treated of by several American authors, and in January, 1867, Dr. Henry Shimer, of Mount Carroll, Ill., proposed for it a new family (*Daktylosphæridæ*),* which has not been accepted by homopterists, for the reason that it was founded on characters of no family value.

All these authors referred to the leaf-louse described by Dr. Fitch, and never dreamed that the insect existed in another type on the roots. During the few years following our civil war a serious disease of the Grape-vine began to attract attention in France, and soon caused so much alarm that the Minister of Agriculture and Commerce in that country offered a prize of 20,000 francs for an effectual and practicable remedy; (1) and a special committee was appointed to draw up a programme of conditions, and award the prize if it saw fit so to do.

The disease was at first designated as *pourridie*, or rotting, the roots becoming swollen and bloated, and finally wasting away. There were no end of surmises and theories as to its cause, until Prof. J. E. Planchon, of Montpellier, in July, 1868, announced ‡ that it was due to the puncture of a minute insect belonging to the plant-louse family (*Aphididæ*), and bearing a close resemblance to our gall-louse. The insect was subsequently described, by the same author, from the apterous form, under the name of *Rhizaphis vastatrix*, and not till September of the same year, ‖ when the winged insect was discovered, did he give it the name by which it is now so well known. In January, 1869, Prof. J. O. Westwood, of Oxford, England, announced § the receipt of both the gall and root-inhabiting types, from different parts of England and Ireland, and his inability to distinguish between the two. In the same article he announced having received the gall-making type from Hammersmith in 1863, and having described it by the name of *Peritymbia vitisana*, in a notice communicated to the Ashmolean Society of Oxford, in the spring of 1868, which communication was, however, never published. In the spring of 1869,¶ M. J. Lichtenstein, of Montpellier, first hazarded the opinion that the Phylloxera, which was attracting so much attention in Europe, was identical with the American insect described by Dr. Fitch. This opinion gave an additional interest to our insect, and I succeeded in 1870, while the Franco-Prussian war was at its highest, and just before the investment of Paris, in establishing the identity of their gall-insect with ours, through correspondence with, and specimens sent to, Dr.

* Proceedings Academy of Natural Sciences, Philadelphia, January, 1867.

‡ *Messager du Midi*, July 22, 1868.

‖ *Comptes rendus de l'Academie des Sciences*, Paris, September 14, 1868.

§ *Gardeners' Chronicle*, January 30, 1869. ¶ *Insectologie Agricole*, 1869, p. 189.

V. Signoret, of that city. During the same year I also established the identity of the gall and root-inhabiting types, by showing that in the fall of the year the last brood of gall-lice betake themselves to the roots and hibernate thereon. In 1871 I visited France and studied their insect in the field; and in the fall of that year, after making more extended observations here, I was able to give absolute proof of the identity of the two insects, and to make other discoveries, which not only interested our friends abroad, but were of vital importance to our own grape growers, especially in the Mississippi Valley. I have given every reason to believe that the failure of the European vine, (*Vitis vinifera*), when planted here, the partial failure of many hybrids with the European *vinifera*, and the deterioration and death of many of the more tender-rooted native varieties, are mainly owing to the injurious work of this insidious little root-louse. It had been at its destructive work for years, producing injury the true cause of which was never suspected until the publication of the article in my fourth Report. I also showed that some of our native varieties enjoyed relative immunity from the insects' attacks, and urged their use for stocks, as a means of reëstablishing the blighted vineyards of Southern France.

The disease continued to spread in Europe, and became so calamitous in the last-named country that the French Academy of Sciences appointed a standing Phylloxera Committee. It is also attracting some attention in Portugal, Austria and Germany, and even in England, where it affects hot-house grapes.

The literature of the subject grew to such vast proportions that, after publishing a biographical review, containing notices and summaries of 483 articles or treatises, published during the four years of 1868–71, MM. Planchon and Lichtenstein gave up the continuance of the work as impracticable.

At the suggestion and with the coöperation of the Société Centrale d'Agriculture de l'Hérault, the French Minister of Agriculture last autumn commissioned Prof. Planchon to visit this country and learn all he could about the insect and its effect on our different vines. Prof. Planchon arrived here the latter part of August and remained over a month, during which time he visited many prominent vineyards in the Eastern States, on Kelley's Island, in Missouri, and in North Carolina. His investigations not only fully corroborated all my previous conclusions regarding the Phylloxera, but gave him a knowledge of the quality of our native grapes and wines which will be very apt to dispel much of the prejudice against them that has so universally possessed his coutrymen, who have not followed our recent rapid progress in viticulture and viniculture, but found their opinions

on the inferior results which attended the infancy of those industries in America. Such, in brief, is the history of the grape Phylloxera. Let us now take a closer insight into the nature of the insect.

The genus *Phylloxera* is characterized by having three-jointed antennæ, the third or terminal much the longest, and by carrying its wings overlapping flat on the back instead of roof-fashion. It belongs to the whole-winged bugs (*Homoptera*), and osculates between two great families of that sub-order, the Plant-lice (*Aphididæ*) on the one hand and the Bark-lice (*Coccidæ*) on the other. In the one-jointed tarsus of the larva or newly-hatched louse, and in being always oviparous, it shows its affinities with the latter family, but in the two-jointed tarsus of the more mature individuals, and in all other characters, it is essentially aphididan. "In every department of natural history a species is occasionally found which forms the connecting link between the two genera, rendering it doubtful under which genus it should properly be arranged. Under such circumstances the naturalist is obliged to ascertain, by careful examination, the various predominating characteristics, and finally place it under the genus to which it bears the closest affinity in all its details." So wrote Audubon and Bachman twenty-eight years ago;* and what is true of genera is equally true of species, families, and of still higher groups. In the deepest sense all Nature is a whole, and all her multitudinous forms of animal and vegetal life are so closely interlinked, and graduate into each other so insensibly, that in founding divisions on too trivial differences we subvert the objects of classification. Thus, instead of founding a new family for this insect, as Dr. Shimer did, and as there seems a tendency on the part of others to do, it is both more consonant with previous custom, and more sensible in every way, to retain it among the *Aphididæ*.

BIOLOGICAL.

Different Forms which the Insect Assumes.—Not the least interesting feature in the economy of our Phylloxera, are the different phases or forms under which it presents itself. Among these forms are two constant types which have led many to suppose that we have to do with two species. The one type, which I have, for convenience, called *gallæcola*, lives in galls on the leaves; the other, which I have called *radicicola*, on swellings of the roots. The subjoined table will assist to a clear understanding of what follows: (2)

Type 1. *Gallæcola.*—(*Vitifoliæ*, Fitch; Fig. 4, *f*, *g*, *h*.)
Type 2. *Radicicola*—
 α, Degraded or Wingless Form. (Fig. 5, *e*, *f*, *g*.)
 β, Perfect or Winged Form. (Fig. 6, *g*, *h*. Fig. 8, *b*.)

* Quadrupeds of North America, vol. i., p. 215.

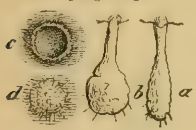
TYPE GALLÆCOLA OR GALL-INHABITING.—The gall or excrescence produced by this insect is simply a fleshy swelling of the under side of the leaf, more or less wrinkled and hairy, with a corresponding depression of the upper side, the margin of the cup being fuzzy, and drawn together so as to form a fimbriated mouth. It is usually cup-shaped, but sometimes greatly elongated or purse-shaped (Fig. 3, *a*, *b*).

Soon after the first vine-leaves that put out in the spring have fully expanded, a few scattering galls may be found, mostly on the lower leaves, nearest the ground. These vernal galls are usually large, (of the size of an ordinary pea,) and the normal green is often blushed with rose where exposed to the light of the sun. On carefully opening one of them (Fig. 4, *d*) we shall find the mother-louse diligently at work surrounding herself with pale-yellow eggs of an elongate oval form, scarcely .01 inch long, and not quite half as thick (Fig. 4, *c*). She is about .04 inch long, generally spherical in shape, of a dull orange color, and looks not unlike an immature seed of the common purslane. At times, by the elongation of the abdomen, the shape assumes, more or less perfectly, the pyriform. Her members are all dusky, and so short compared to her swollen body, that she appears very clumsy, and undoubtedly would be outside of her gall, which she never has occasion to quit, and which serves her alike as dwelling-house and coffin. More carefully examined, her skin is seen to be shagreened or minutely granulated and furnished with rows of minute hairs, which will be more particularly referred to in the appendix. The eggs begin to hatch, when six or eight days old, into active little oval, hexapod beings, which differ from their mother in their brighter yellow color and more perfect legs and antennæ, the tarsi being furnished with long, pliant hairs, terminating in a more or less distinct globule. These hairs were called *digituli* by Dr. Shimer, and they lose their globular tips and become more or less worn with age. In hatching, the egg splits longitudinally from the anterior end, and the young louse, whose pale yellow is in strong contrast with the more dusky color of the egg-shell, escapes in the course

[Fig. 2.]

UNDER SIDE OF LEAF COVERED WITH GALLS.

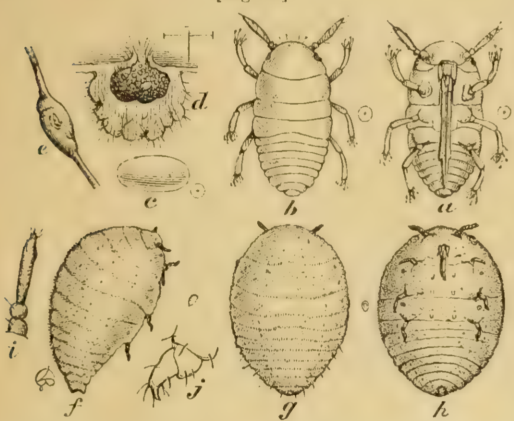
[Fig. 3.]



a and *b*, elongated galls; *c* and *d*, upper and under side of abortive galls.

of two minutes. Issuing from the mouth of the gall, these young lice scatter over the vine, most of them finding their way to the tender terminal leaves, where they settle in the downy bed which the tomentose nature of these leaves affords, and commence pumping up and appropriating the sap. The tongue-sheath is blunt and heavy, but the tongue proper—consisting of three brown, elastic, and wiry filaments, which, united, make so fine a thread as scarcely to be visible with the strongest microscope—is sharp, and easily run under the parenchyma of the leaf. Its puncture causes a curious change in the tissues of the leaf, the growth being so stimulated that the under side bulges and thickens, while the down on the upper side increases in a circle around the louse, and finally hides and covers it as it recedes more and more within the deepening cavity.(3) Sometimes the lice are so crowded that two occupy the same gall. If, from the premature death of the louse, or other cause, the gall becomes abortive before being completed, then the circle of thickened down or fuzz enlarges with the expansion of the leaf, and remains (Fig. 4, *c*) to tell the tale of the futile effort. Otherwise, in a few days the gall is formed, and the inheld louse, which, while eating its way into house and home, was also growing apace, begins a parthenogenetic maternity by the deposition of fertile eggs, as her immediate parent had done before. She increases in bulk with pregnancy, and one egg follows another in quick succession, until the gall is crowded. The mother dies and shrivels, and the young, as they hatch, issue and found new galls. This process continues during the summer until the fifth or sixth generation. Every egg brings forth a fertile female, which soon becomes wonderfully prolific. The number of eggs found in a single gall averages about 200; yet it will sometimes reach as many as 500, and, if Dr. Shimer's observations can be relied on, it may even reach 5,000.* I have never found any such number myself; but, even supposing there are but five generations during the year, and

[Fig. 4.]



TYPE GALLÆCOLA:—*a*, *b*, newly-hatched larva, ventral and dorsal view; *c*, egg; *d*, section of gall; *e*, swelling of tendril; *f*, *g*, *h*, mother gall-louse—lateral, dorsal and ventral views; *i*, her antenna; *j*, her two-jointed tarsus. Natural sizes indicated at sides.

**Practical Entomologist*, vol. i., p. 17.

taking the lowest of the above figures, the immense prolificacy of the species becomes manifest. Small as the animal is, the product of a single year, even at this low estimate, would encircle the earth over thirty times if placed in a continuous line, each individual touching the end of another. Well it is for us that they are not permitted to multiply in this geometrical ratio! Nevertheless, as summer advances, they do frequently become prodigiously multiplied, completely covering the leaves with their galls, and settling on the tendrils, leaf-stalks, and tender branches, where they also form knots and rounded excrescences (Fig. 4, *e*), much resembling those made on the roots. In such a case, the vine loses its leaves prematurely. Usually, however, the natural enemies of the louse seriously reduce its numbers by the time the vine ceases its growth in the fall, and the few remaining lice, finding no more succulent and suitable leaves, seek the roots. Thus, by the end of September, the galls are mostly deserted, and those which are left are almost always infested with mildew (*Botrytis viticola*, Berkely), and eventually turn brown and decay. On the roots, the young lice attach themselves singly or in little groups, and thus hibernate. The male gall-louse has never been seen, and there is every reason to believe that he has no existence. (4) Nor does the female ever acquire wings. Indeed, I can not lay too much stress on the fact that *gallæcola* occurs only as an agamic and apterous female form. It is but a transient summer state, not at all essential to the perpetuation of the species, and does, compared with the other type, but trifling damage. (5) I have found it occasionally on all species of the Grape-vine (*vinifera*, *ripana*, *æstivalis*, and *Labrusca*) cultivated in the Eastern and Middle States, and on the wild *cordifolia;* but it flourishes only on the River-bank grape (*riparia*), and more especially on the Clinton and Taylor, with their close allies. Thus, while legions of the root-inhabiting type (*radicicola*) are overrunning and devastating the vineyards of France, this *gallæcola* is almost unknown there, except on such American varieties as it infests with us. A few of its galls have been found at Sorgues, on a variety called Tinto; and others have been noticed on *vinifera* vines interlocking infested American vines, or have been produced by purposed contact with the young *gallæcola*. Similarly, there are many varieties, especially of *Labrusca*, which, in this country, suffer in the roots, and never show a gall on the leaves.

The precise conditions which determine the production and multiplication of *gallæcola* can not now, if they ever can, be stated; but it is quite evident that the nature and constitution of the vine are important elements, since such vines as the Herbemont often bear witness, by their leaves covered with abortive galls, to the futile efforts

the lice sometimes persist in making to build in uncongenial places. Yet other elements come into play, and nothing strikes the observer as more curious and puzzling than the transitory nature of these galls, and the manner in which they are found—now on one variety, now on another. (6)

I was formerly inclined to believe that *gallæcola* was a necessary phase in the annual cycle of the insect's mutations: in other words, that it was essential to the continuance of the species, and was probably the product of the egg laid by the winged and impregnated female. On this hypothesis I imagined that *gallæcola* was probably the invariable precursor of *radicicola* in an uninfested vineyard, and that, if galls were not allowed to develop in such a vineyard, it would not suffer from root-lice. More extensive experience has satisfied me that the hypothesis is essentially erroneous, and that, while the first galls may sometimes by produced by lice hatched from the few eggs deposited above-ground by the winged female, they are more often formed by young lice hatched on the roots, and which, wandering away from their earthy recesses, are fortunate enough to find suitable leaf conditions. It is barely possible that under certain circumstances, as, for instance, on our wild vines, where the soil around the roots is hard and compact, *gallæcola* may become more persistent, and pass through all the phases belonging to the species without descending to the roots—the eggs wintering on the ground, or the young under the loose bark, or upon the canes. For a somewhat similar state of things actually takes place with another plant-louse (*Eriosoma pyri*, Fitch,) which in the Western United States normally inhabits the roots of our apple trees, and only exceptionally the branches; while in the moister Atlantic States, and in England and moister parts of Europe, where it was introduced from this country, it normally infests the branches, and more exceptionally the roots. But there are no facts yet known to prove such to be the case with the Grape Phylloxera, even on our wild vines, and I do not believe that it ever is the case in our cultivated vineyards.

As already indicated, the autumnal individuals of *gallæcola* descend to the roots, and there hibernate. There is every reason to believe also that, throughout the summer, some of the young lice hatched in the galls are passing on to the roots; as, considering their size, they are great travelers, and show a strong predisposition to drop, their natural lightness, as in the case of the young *Cicada*, and of other insects which hatch above but live under ground, enabling them thus to reach the earth with ease and safety. At all events, I know, from experiment, that the young *gallæcola*, if confined to vines on which they do not normally, and perhaps can not, form galls, will, in

the middle of summer, make themselves perfectly at home on the roots.

TYPE RADICICOLA OR ROOT-INHABITING.—We have seen that, in all probability, *gallæcola* exists only in the apterous, shagreened, non-tubercled, fecund female form. *Radicicola*, however, presents itself in two principal forms. The newly-hatched larvæ of this type are undistinguishable, in all essential characters, from those hatched in the galls; but in due time they shed the smooth larval skin, and acquire raised warts or tubercles (7) which at once distinguish them from *gallæcola*. In the development from this point the two forms are separable with sufficient ease: one (α) of a more dingy greenish yellow, with more swollen fore-body, and more tapering abdomen; the other (β) of a brighter yellow, with the lateral outline more perfectly oval, and with the abdomen more truncated at tip. (8)

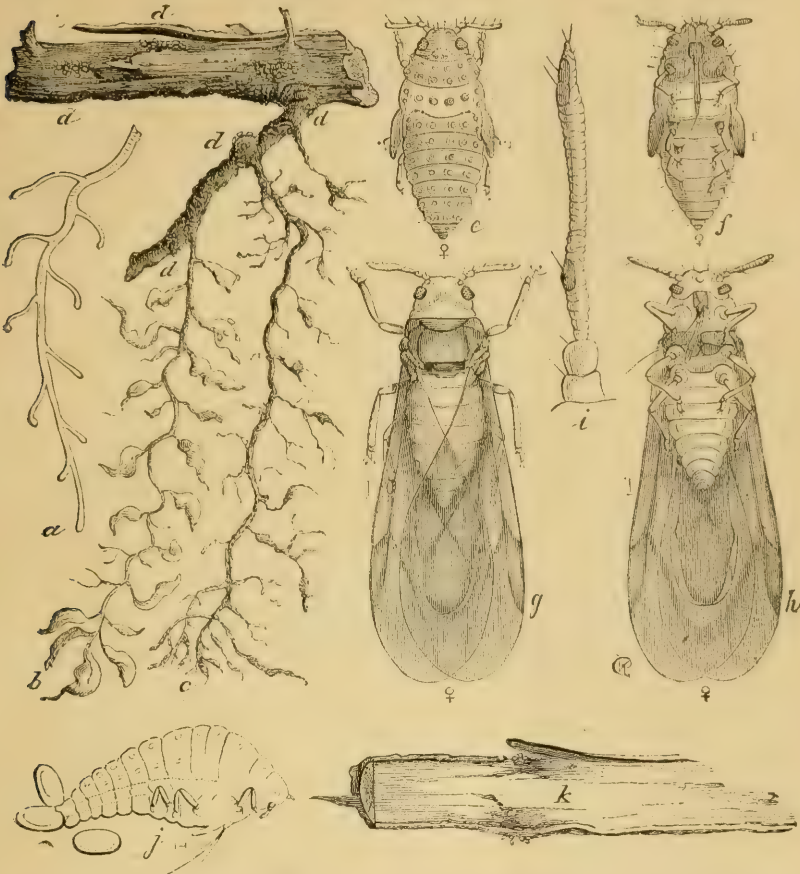
[Fig. 5.]

TYPE RADICICOLA.—*a*, roots of Clinton vine, showing relation of swellings to leaf-galls, and power of resisting decomposition; *b*, larva as it appears when hibernating; *c*, *d*, antenna and leg of same; *e*, *f*, *g*, forms of more mature lice, *h*, granulations of skin; *i*, tubercle; *j*, transverse folds at border of joints; *k*, simple eyes.

The first or mother form (Fig. 5, *f*, *g*) is the analogue of *gallæcola*, as it never acquires wings, and is occupied, from adolescence till death, with the laying of eggs, which are less numerous and somewhat larger than those found in the galls. I have counted in the spring as many as two hundred and sixty-five eggs in a cluster, and all evidently from one mother, who was yet very plump and still occupied in laying. As a rule, however, they are less numerous. With pregnancy this form becomes quite tumid and more or less pyriform, and is content to remain with scarcely any motion in the more secluded parts of the roots, such as the creases, sutures, and depressions, which the knots afford. The skin is distinctly shagreened (Fig. 5, *h*,) as in *gallæcola*. The warts, though usually quite visible with a good lens, are at other times more or less obsolete, especially on the abdomen, (9) The eyes, which were quite perfect in the larva, become more simple with each molt, until they consist, as in *gallæcola*, of but triple eyelets (Fig. 5, *k*.) and, in the general structure, this form becomes more degraded with maturity, wherein it shows the affinity of the species to the *Coccidæ*, the females of which, as they mature, generally lose all trace of the members they possessed when born.

The second or more oval form (Fig. 5, *e*) is destined to become winged. Its tubercles, when once acquired, are always conspicuous;

[Fig. 6]



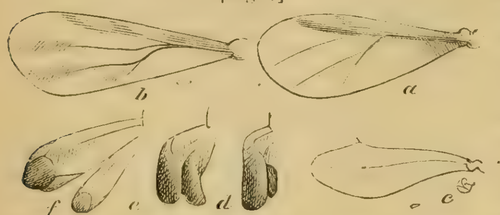
TYPE RADICICOLA:—*a*, shows a healthy root; *b*, one on which the lice are working, representing the knots and swellings caused by their punctures; *c*, a root that has been deserted by them, and where the rootlets have commenced to decay; *d*, *d*, *d*, show how the lice are found on the larger roots; *e*, female pupa, dorsal view; *f*, same, ventral view; *g*, winged female, dorsal view; *h*, same, ventral view; *i*, magnified antenna of winged insect; *j*, side view of the wingless female, laying eggs on roots; *k*, shows how the punctures of the lice cause the larger roots to rot.

it is more active than the other, and its eyes increase rather than diminish in complexity with age. From the time it is one-third grown, the little dusky wing-pads may be discovered, though less conspicuous than in the pupa state, which is soon after assumed. The pupæ (Fig. 6, *e*, *f*) are still more active, and, after feeding a short time, they make their way to the light of day, crawl over the ground and over the vines, and finally shed their last skin and assume the winged state. In this last molt the tubercled skin splits on the back, and is soon worked off, the body in the winged insect having neither tubercles nor granulations.

In the great majority of insects the wings in the pupa are simply compressed and thickened without being folded, and in the imago they expand without material change in form. Those of our *Phylloxera* are rolled up both from the sides and the end, and, in expanding, they unroll in the manner designated at Figure 7, *d, e, f*—the whole operation requiring but about five minutes. At first, and for some time after the molt, the color of the body of the new-fledged Phylloxera is of a uniform bright, deep yellow, with the wings white and rather opaque, and the eyes brown. The dark thoracic band and more diaphanous and smoky nature of the wings are gradually acquired in the course of a day, and the insect finally presents the appearance of Figure 6, *g, h*. The wings when highly magnified are seen to be thickly covered with minute hooks (Fig. 8, *f*).

These winged insects are most abundant in August and September, but may be found as early as the first of July, and until the vines cease growing in the fall. The majority of them are females, with the abdomen large, and more or less elongate. The veins of the front wing are not connected (Fig. 7, *a*), and, by virtue of the large abdomen, the body appears somewhat constricted behind the thorax. From two to five eggs may invariably be found in the abdomen of these, and are easily seen when the insect is held between the light, or mounted in balsam or glycerine. A certain proportion have an entirely different shaped and smaller body, the abdomen being short, contracted, and terminating in a fleshy and dusky penis-like protuberance; the limbs stouter, and the wings proportionally larger and stouter, with their veins connecting (Fig. 7, *b*). This shorter form (Fig. 8, *b*) never has eggs in the abdomen, but, instead, a number of vesicles (Fig. 8, *e*), containing granulations in sacs. These granulations have much the appearance of spermatozoa, and seem to have a Brownian movement, but are without tails.

[Fig. 7]

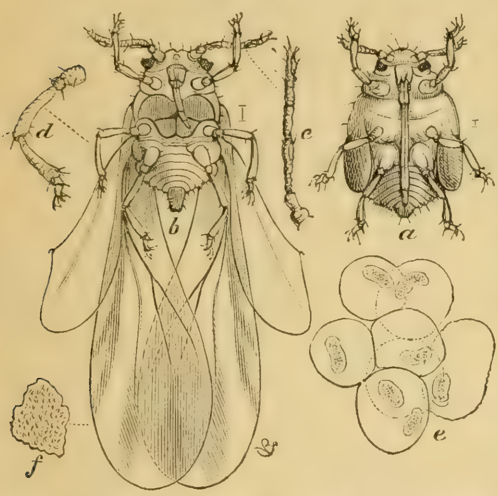


Pterogostic Characters: — *a*, *b*, different venation of front-wing; *c*, hind-wing; *d*, *e*, *f*, showing development of wings.

This form has been looked upon as the male by myself, Planchon, Lichtenstein and others. Yet I have never succeeded in witnessing it performing the functions of a male, nor has any one else that I am aware of. The males in all plant-lice are quite rare, and, in the great majority of species, unknown. Where known, this sex bears about the same relation to the female as the shorter and smaller Phylloxera just described does to the larger. These same differences observed in

the winged insects obtain in the other species of the genus that are known, and have always been looked upon as sexual. Signoret, an authority on these insects, once so looked upon them,(10) but has lately declared the shorter form to be a female emptied of her eggs. If this be so, then the eggs must be laid before the insect arrives at maturity (a highly improbable circumstance) ; for the characteristics which distinguish it are to be noticed in the pupa (Fig. 8, *a*), which is almost as broad as long, with very large wing-pads and strong limbs ; while the winged insect does not, as we have seen, carry any eggs. But, whatever the true nature and functions of these problematic or gynandrous individuals, it would seem, from some exceedingly interesting observations lately made by Balbiani,* that they can not be males, if there be any such thing as unity of habit and character among the species of the genus. Balbiani has made the curious discovery, in the annual development of *Phylloxera quercus*, that the winged individuals, which appear in August, fly off to new leaves and deposit their unimpregnated eggs, to the number of five to eight. These eggs are of two different sizes, the smaller being readily separated from the larger. They hatch in about a dozen days, the smaller giving birth to males, and the larger to females, which have neither mouth-parts nor digestive organs, and neither grow nor molt after birth. The sole aim of their existence is the reproduction of the species, and they crawl actively about and gather in little multitudes in the crevices and interstices which are afforded them. The male, except in size, seems to differ from the female only in having a small conical tubercle, which serves as sexual organ. Coitus lasts but a few minutes, and the same male may serve several females. Four or five days after birth the female lays a solitary egg, which, increasing somewhat after impregnation. had caused her abdo-

[Fig. 8.]



TYPE RADICICOLA:—*a*, *b*, pupa and imago of a problematic individual, or supposed male; *c*, *d*, its antenna and leg; *e*, vesicles found in abdomen.

Comptes Rendus de l'Académie des Sciences, Paris, 1873, p. 884.

men to swell and enlarge a little prior to oviposition. Two or three days after this operation the mother dies; but the males live as long again.

This solitary egg, which Balbiani calls the winter egg, soon takes on a dark color, which indicates its fecundity and distinguishes it from parthenogenetic eggs of both the winged and wingless females. It is surmised that this egg passes the winter to give birth in spring to the form destined to recommence the cycle of development belonging to the species.

These discoveries are truly remarkable, and appear to me all the more so since Balbiani* likewise found that the individuals which never become winged attain maturity without laying eggs on the leaves on which they were born, but crawl on to the branches and in the interstices of the old scales at the base of the new year's growth. There they lay a number of eggs, *which are absolutely like those deposited by the winged females, and, like them, produce the sexual individuals: i. e., both males and females.* Now, this does not correspond with what I have seen myself of the species, or with what has been described by others; for the apterous individuals of *quercus* surround themselves with eggs on the leaves where they are born.

M. Maxime Cornu has already announced having found a sexual individual, without mouth-parts, of the Grape Phylloxera; and it is quite likely, now that Balbiani has paved the way, that we shall next year have its natural history complete. But whether the Grape Phylloxera produces this fecundated and solitary egg or not, such an egg is neither essential to its winter life, nor to that of an American species (*Phylloxera Rileyi* Lichtenstein), which will be described further on, and which is, in every respect, very closely allied to the European *quercus*.

While, therefore, there is yet much to learn in the life-history of our Grape Phylloxera, the facts which I have already unequivocally stated, as well as those which I shall now proceed to give, remain indisputable, and do not seem fully to accord with Balbiani's discoveries.

As fall advances the winged individuals become more and more scarce, and as winter sets in only eggs, newly-hatched larvæ, and a few apterous egg-bearing mothers, are seen. These last die and disappear during the winter, which is mostly passed in the larva state, with here and there a few eggs. The larvæ thus hibernating (Fig. 5, *b*) become dingy, with the body and limbs more shagreened and the claws and *digituli* less perfect than when first hatched; and, of thousands examined, all bear the same appearance, and all are furnished with strong suckers. As soon as the ground thaws and the sap starts in the

* *Auctore* Dr. Fr. Cazalis, as reported in the *Messager du Midi*, November 16, 1873.

spring, these young lice work off their winter coat, and, growing apace, commence to deposit eggs. All, without exception, so far as I have seen,* become mothers, and assume the degraded form (a) already described.

At this season of the year, with the exuberant juices of the plant, the swellings on the roots are large and succulent, and the lice plump to repletion. One generation of the mother form (a) follows another—fertility increasing with the increasing heat and luxuriance of summer—until at least the third or fourth has been reached before the winged form (β) makes its appearance in the latter part of June or early in July. (11)

Such are the main features which the development of the insect presents to one who has studied it in the field as well as in the closet.

This polymorphism, which at first strikes us as singular, is quite common among plant-lice, and many curious instances of still more striking character might be given. Even the differences themselves between *gallæcola* and *radicicola* are more apparent than real. Individuals of the latter are often met with, which, in the comparative obsoleteness of their tubercles, are almost undistinguishable from the former; and the tubercles, like many other purely dermal appurtenances, are of an evanescent and unimportant character. Many insect larvæ, which are normally granulated with papillæ, not unfrequently have these more or less obsolete, and at some stages of growth have the skin absolutely smooth. The same thing holds true of tubercles, which, as in the case of the Imported Currant-worm (*Nematus ventricosus* Klug), to be presently treated of, are often completely cast off at a molt. In *Phylloxera* they are very variable in size, as we shall see, in *Rileyi;* and in *quercus*, according to several reliable authors, the tubercles which are characteristic of the species in Southern France are entirely wanting around Paris. If we carefully study them in *vastatrix*, we shall find that they consist of points where the granulated skin is gathered around a fleshy hair in little rugosities, and becomes darker (Fig. 5, i). They do not occur in the newly hatched larva, are not visible immediately after each molt, and are lost again in the winged individuals. In the form *gallæcola* we shall find, upon careful examination, especially of the exuvia, that, as Max.Cornu has shown, there are rows of short hairs, extending beyond the natural granulations, and corresponding to those on the tubercles of *radicicola*. *These hairs are more visible on the younger and smoother lice after the first molt; and they are sometimes so stout, particularly on the abdomen, as to remind one of those on *Rileyi*, to be described. The ventral characteristics of the two types are identical.

* I have examined thousands in the vineyard in early spring, and other thousands reared, artificially in a warm room in winter.

Since I proved, in 1870, the absolute identity of these two types by showing that the gall-lice become root-lice, the fact has been repeatedly substantiated by different observers. Yet, strange to say, no one has heretofore succeeded in making gall-lice of the young hatched on the roots, though I formerly supposed that Signoret had done so. It is, therefore, with much satisfaction that I record the fact of having succeeded this winter in obtaining galls on a young Clinton vine from young *radicicola*, and of thus establishing beyond peradventure, the specific interrelation and identity of the two types. I make this announcement with all the more pleasure, that for three years past, both on vines growing out-doors and in pots in-doors, I had in vain attempted to obtain the same result. (12)

PRACTICAL CONSIDERATIONS.

The more manifest and external Effects of the Phylloxera Disease.—The result which follows the puncture of the root-louse is an abnormal swelling, differing in form according to the particular part and texture of the root. These swellings, which are generally commenced at the tips of the rootlets, where there is excess of plasmatic and albuminous matter, eventually rot, and the lice forsake them and betake themselves to fresh ones—the living tissue being necessary to the existence of this as of all plant-lice. The decay affects the parts adjacent to the swellings, and on the more fibrous roots cuts off the supply of sap to all parts beyond. As these last decompose, the lice congregate on the larger ones, until at last the root system literally wastes away. (13)

During the first year of attack there are scarcely any outward manifestations of disease, though the fibrous roots, if examined, will be found covered with nodosities, particularly in the latter part of the growing season. The disease is then in its incipient stage. The second year all these fibrous roots vanish, and the lice not only prevent the formation of new ones, but, as just stated, settle on the larger roots, which they injure by causing hypertrophy of the parts punctured, which also eventually become disorganized and rot. At this stage the outward symptoms of the disease first become manifest, in a sickly, yellowish appearance of the leaf and a reduced growth of cane. As the roots continue to decay, these symptoms become more acute, until by about the third year the vine dies. Such is the course of the malady on vines of the species *vinifera*, when circumstances are favorable to the increase of the pest. When the vine is about dying it is generally impossible to discover the cause of the death, the lice, which had been so numerous the first and second years of invasion, having left for fresh pasturage.

MODE OF SPREADING.—The gall-lice can only spread by traveling, when newly hatched, from one vine to another; and, if this slow mode of progression were the only one which the species is capable of, the disease would be comparatively harmless. The root-lice, however, not only travel under-ground along the interlocking roots of adjacent vines, but crawl actively over the surface of the ground, or wing their way from vine to vine, and from vineyard to vineyard. Doubts have been repeatedly expressed by European writers as to the power of such a delicate and frail-winged fly to traverse the air to any great distance. "On a calm, clear day, the latter part of last June, it was my fortune to witness a closely-allied species (*Phylloxera caryæfoliæ* Fitch), of the same size and proportions, swarming on the wing to such an extent that to look against the sun revealed them as a myriad silver specula. They settled on my clothing by dozens, and any substance in the vicinity that was the least sticky was covered with them. With such a sight before one's eyes, and with full knowledge of the prolificacy of these lice, it required no effort to understand the fearful rapidity at which the Phylloxera disease has spread in France, or the epidemic nature it has assumed. Imagine such swarms, mostly composed of egg-bearing females, slowly drifting, or more rapidly blown, from vineyard to vineyard; imagine them settling upon the vines and depositing their eggs, which give birth to fecund females, whose progeny in five generations, and probably in a single season, may be numbered by billions, and you have a plague (should there be no conditions to prevent that increase) which, though almost invisible and easily unnoticed, may become as blasting as the plagues of Egypt." *

As early as 1871 I showed with what facility and power the species referred to in the above extract can take wing when the atmospheric conditions are favorable; and on the 27th of last September, the weather being quite warm and summer-like, with much moisture in the atmosphere, I witnessed the same power of flight in the Grape Phylloxera. Some two hundred winged individuals, which I had confined, became very active and restless, vigorously vibrating their wings and beating about their glass cages. Upon opening the cages, the lice began to dart away and were out of sight in a twinkle. They have been caught in spider-webs in Europe, and I have repeatedly captured them on sheets of paper prepared with bird-lime and suspended in an infested vineyard; and am satisfied that they can sustain flight for a considerable time under favorable conditions, and, with the assistance of the wind, they may be wafted to great distances. These winged females are much more numerous in the fall of the year than

* Fifth Rep., pp. 72, 73.

has been supposed by entomologists. Wherever they settle, the few eggs which each carries are sufficient to perpetuate the species, and thus spread the disease, which, in the fullest sense, may be called contagious. Whether in a state of nature these winged females show a preference for any one part of the vine in the consignment of their eggs, is not yet known. It is quite certain, however, that they do not reënter the ground. Neither do we know whether—in the light of Balbiani's discoveries regarding the European Oak Phylloxera—the young hatching from these eggs produce the diminutive sexual individuals already described. In confinement I have had such eggs deposited both on the leaves and on the buds, and from the preference which, in ovipositing, these aerial mothers showed for little balls of cotton placed in the corners of their cages, I infer that the more tomentose portions of the vine, such as the bud, or the base of a leaf-stem, furnish the most appropriate and desirable *nidi*. On this hypothesis it is quite possible for the insect to be introduced from vineyard to vineyard, or from country to country, as well upon cuttings as upon roots.

The young lice from the unimpregnated winged females hatch in ten or twelve days after the laying of the eggs, under favorable conditions of temperature. It is possible, however, that the later deposited eggs remain unhatched throughout the winter. The few young, from such eggs, which I have had, were neglected through absence from home, and unfortunately (Balbiani's discovery was unknown to me at that time) none were preserved. I can not say positively, therefore, that they were not mouthless and sexual, but a superficial examination revealed no characters which would distinguish them from the young of the apterous females.

SUSCEPTIBILITY OF DIFFERENT VINES TO THE DISEASE.—As a means of coping with the Phylloxera disease, a knowledge of the relative susceptibility of different varieties to the attacks and injuries of the insect is of paramount importance. As is so frequently the case with injurious insects, and as we have a notable instance in the common Currant Aphis (*Aphis ribesii*), which badly affects the leaves of some of the Currants, but never touches the Gooseberry which belongs to the same genus, the Phylloxera shows a preference for and thrives best on certain species, and even discriminates between varieties; or, what amounts to the same thing, practically, some varieties resist its attacks and enjoy a relative immunity from its injuries. It would, I fear, be useless, and certainly unnecessary here, to attempt to ascertain the reason why certain vines thus enjoy exemption while others so readily succumb; but in a broad way it may be stated that there is a relation between the susceptibility of the vine and the character of its roots—the slow-growing, more tender-wooded and consequently

more tender-rooted varieties succumbing most readily; the more vigorous growers resisting best.

I have already given, in my fourth Report, Dr. Engelmann's classification of our different species of *Vitis*, and in the Appendix will be found the synopsis kindly prepared for me by that well-known botanist, with additional remarks, and embodying his latest opinions and observations. (14)

Following this synopsis, I will now proceed to indicate the relative susceptibility to the disease, of the cultivated species and their varieties—revising and perfecting the list given in the report just quoted by aid of repeated and extended observations since made. For the sake of conciseness, I will indicate this susceptibility by letters and numerals as follows:

o = No perfect leaf-galls found; or not at all subject to them.

a = Leaf-galls very rarely found.

b = Leaf-galls more frequently met with.

c = Leaf-galls most abundantly found; or very much subject to them.

0 = Entirely free from root-lice.

1 = Having the root-lice in usually small numbers, but countervailing their punctures either by the innate toughness of fiber, or the power to resist decomposition.

2 = Having the root-lice more abundant and suffering more from their attacks.

3 = Most subject to the root-lice, and dying from their attacks when the conditions are favorable to their increase.

EUROPEAN VINE (*Vitis vinifera*)—*o*, 3. The very few exceptions, already mentioned, where galls have been found on the leaves of this species, will scarcely invalidate the rule that it is free from galls. Regarding its susceptibility to the attacks of the root-lice, it generally succumbs a few years after planting. (15)

RIVER BANK GRAPE (*riparia*)—ALVEY—*a*, 2. CORNUCOPIA (hybrid with *vinifera*)—*o*, 2. CLINTON—*c*, 1. Where the leaf-galls are very abundant I have often found the root-lice less so, and *vice versa*. The roots have such vitality that disorganization does not always follow the puncture of the louse, and new rootlets often push out from the swellings. DELAWARE—*b*, 2. GOLDEN CLINTON—*a*, 1. LOUISIANA—(some say a seedling of *vinifera;* others again believe it *æstivalis*)—*a*, 1. MARION—*b*, 1. OTHELLO (hybrid with *vinifera*)—*a*, 2. TAYLOR—*c*, 1. Much as with Clinton.

SUMMER GRAPE (*æstivalis*)—HERBEMONT—*a*, 1. CUNNINGHAM—*o*, 1. CYNTHIANA—*a*, 1. NORTON'S VIRGINIA—*o*, 1. RULANDER—*o*, 1. TELEGRAPH—*o*, 1.

NORTHERN FOX (*Labrusca*)—CATAWBA—*o*, 3. Suffering almost as badly as the varieties of *vinifera*. CHALLENGE (hybrid with *vinifera*)—*o*, 1. CREVELING—*a*, 2. CONCORD—*a*, 1. DIANA—*o*, 2. DRACUT AMBER—*o*, 1. GOETHE (hybrid with *vinifera*)—*o*, 2. HARTFORD—*o*, 2

Iona—*o*, 3. Isabella, or seedlings thereof—*o*, 2. Israella—*o*, 1. Ives—*o*, 2. Martha—*o*, 1. Maxatawney—*o*, 2. North Carolina—*o*, 2. Northern Muscadine—*o*, 1. Rebecca—*o*, 2. Salem—*o*, 2. Wilder (hybrid with *vinifera*)—*o*, 1.

SOUTHERN FOX (*vulpina.*)—*o*, 0. From the investigations of Prof. Planchon it results—as was anticipated from the great differences in character which it presents compared with the others—that this species is entirely free from Phylloxera in any form. The root is not only very tough, but has a perceptibly bitter taste, which, doubtless, renders it obnoxious to the insect. Prof. Planchon examined it thoroughly in North Carolina, where other vines in the vicinity were suffering from the insect.

From the above enumeration we may gather that, with the exception of *vulpina*, no species of cultivated vine is entirely free from the attacks of either the gall-making or root-inhabiting types; nevertheless, *vinifera* is least and *riparia* most subject to the former; *æstivalis* least and *vinifera* most subject to the latter.

Of *vinifera*, a few varieties under certain conditions seem to exhibit a degree of resistance in this country, and it is singular that some relative immunity has not as yet been noticed among the varieties of this species in Europe.*

Of *riparia*, the Clinton, Taylor, Golden Clinton and Marion, seem best to resist.

Of *æstivalis*, all the species enumerated resist well, and I would especially mention Norton's, Herbemont and Cunningham as vigorous growers.

Of *Labrusca*, the Concord, Dracut Amber, Israella, Martha, North Carolina and Wilder resist well.

This enumeration is founded principally on the effects of Phylloxera in the central portion of Missouri, as ascertained by quite extensive notes and observations made during the past two years. I have also examined many of the varieties mentioned, with similar results, in portions of Kansas, Illinois, New Jersey, Pennsylvania and New York. Many other varieties have been examined, but only in isolated instances, and I have thought best not to place any in the lists which I have not repeatedly examined and studied. The Arnold's hybrids, which I have examined, all suffer, but some of them more than others.

Prophylactic Means of coping with the Disease.—It occurred to me that by grafting the more susceptible onto the roots of the more resistant varieties, we might, in a great measure,

* Since the above was written, I notice that M. A. Pellicot already announces the fact that a certain variety (*Colombaud*) has shown a comparative power of resistance—living long after other varieties succumb. (*Messager Agricole, Fév.* 10, 1874, p. 14.

counteract the disease, even if all other remedies failed. In the grape-growing districts of France, where the disease is so sweeping, and where the grape is so exclusively grown that its failure affects whole communities, the people may be obliged, and can afford to go to much labor and expense in the use of insecticides to save their vines. Such insecticides may also be used in this country, where it is desired to save a few choice vines regardless of expense and time. But I greatly fear that no direct remedy for such an under-ground enemy will ever be discovered that will not entail too much labor and expense to be used, to any great extent, by our own grape-growers, who will either prefer to confine their attention to varieties which resist, or abandon the business entirely. Yet if it shall once be demonstrated that varieties which now fail may be grown when grafted onto those which resist, I see no reason why it should not become as much a custom and a maxim among grape-growers, to use some other vine as stock for such varieties as the Catawba, for instance, as it already is among pear-growers to use the quince, or among cherry growers to use Mahaleb, Mazard or Morello, as stocks.

In the course of a year or two we shall be able to fairly judge of the efficacy of the plan, for aside from the trials that I am making in this country, others are being made on an extensive scale in France. Quite a number of plants, for the purpose of experiment, were sent over there from this country in the spring of 1872; and the demand has now become so great that a single firm, Isidor Bush & Co., of St. Louis, has lately received orders for about four hundred thousand cuttings to be consigned to one place, Montpellier, and consisting of such varieties as have been recommended by Prof. Planchon and myself, as best resisting the disease. There is every reason to hope for the best results from these importations, as those vines, such as Herbemont, Cunningham, Concord, Clinton, etc, which best resist here, and which were planted there in 1871 and 1872, in Phylloxera-infested districts, have, thus far, done surprisingly well, as MM. J. Leenhardt-Pomier, V. Pulliat and others testify. (16.)

As bearing on this subject, we have seen that the Southern Fox (*vulpina*) is the only species that is totally exempt from both leaf- and root-lice. This species is of no value whatever in the latitude of St. Louis, and does not flourish above latitude 35°. It can not, therefore, be made of any avail here, and it is doubtful whether they will be able to profit by its immunity in the blighted French vineyards. It may grow and ripen its fruit in the extreme southern portion of that country, but it requires a special mode of culture, and the lateness and irregularity of its ripening are no advantage; while the great difference between its wood and that of the other

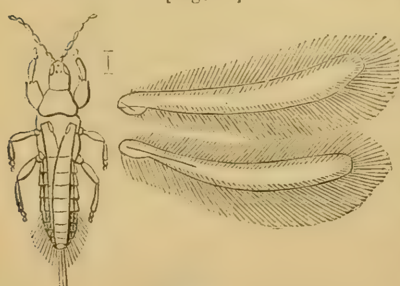
cultivated species, must render it difficult to successfully graft them upon it. I mention these things because M. LeHardy de Beaulieu, of Augusta, Georgia, supported in his views by Mr. Berkmans of the same place, has lately published a pamphlet highly extoliing the Scuppernong as the vine of all others to redeem the blighted French vineyards. It is well to consider possible drawbacks, and often saves sore disappointment.

Other preventive Measures.—In planting a new vineyard the greatest care should be taken not to introduce the Phylloxera on the young plants, and a bath of weak lye or strong soap-suds before planting will, perhaps, prove the best safeguard. Remembering that the lice are spreading over the ground from July till fall, and principally in the months of August and September, a thorough sprinkling of the surface with lime, ashes, sulphur, salt or other substance destructive to insect life, will no doubt have a beneficial effect in reducing their numbers and preventing their spread.

The insect has been found to thrive less and to be, therefore, less injurious in a sandy soil; while a mixture of soot with the soil has had a beneficial effect in destroying the pest. I have therefore recommended for the more susceptible varieties, that they be planted in trenches first prepared with a mixture of sand and soot. An addition of lime will also prove beneficial. There is every reason to believe that vines are rendered less susceptible to the disease by a system of pruning and training that will produce long canes and give them as nearly as possible their natural growth. At Mr. Thos. Meehan's, Germantown, Pa., I could find no lice on Clinton or Concord grown in sward against a wall and unpruned; while on the shorter, cultivated Clintons in the vineyard, the lice were found without difficulty.

Natural Enemies.—There are a number of different predaceous insects which serve to keep the leaf-lice in check; but as the injury is mostly done under-ground it will suffice to enumerate the principal of these in this connection. The most efficient is a black species of Fringe-wing or Thrips with white wings (*Thrips phylloxeræ* of my MS.). The egg, which is thrice as large as that of the louse, ellipsoidal and with a faceted surface, is deposited within the gall among its legitimate inhabitants; and the young Thrips, which differ from their parents not only in lacking wings but in being of a blood-red color, with only the extremities and the members black, play havoc with the lice. They are active, supple creatures, and turn up

[Fig. 9.]



Thrips.

menacingly the posterior part of the body when disturbed. They are found in several different kinds of Phylloxera galls, and do more than any other species to keep the leaf-inhabiting Grape Phylloxera within bounds.

The next most efficient aid in the destruction of the leaf-lice is found among the Lace-wing flies, one species of which, more especially, viz.: the Weeping Lace-wing (*Chrysopa plorabunda* Fitch), I find very frequently within the galls devouring their contents. These flies are known as well by their brilliantly golden eyes as by the peculiarly offensive odor, as of human ordure, which some of them emit.

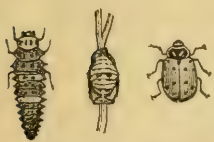
[Fig. 10.]

a b c d

LACE-WING FLY:—*a*, eggs; *b*, larva; *c*, cocoon; *d*, fly.

The eggs are adroitly deposited (Fig. 10, *a*) at the tip of long, silk-like stalks, in order to prevent the first-born larvæ from exercising their cannibalistic propensities on their yet unborn brethren.* The larva (Fig. 10, *b*) is very rapacious, and, when ready to transform, winds itself up into a wonderfully small cocoon (considering the size of the insect which makes it and which issues from it) which is spun from the extremity of the body and from which it issues, when about to acquire wings, through a neatly-cut, circular aperture.

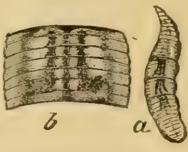
[Fig. 11.]



LADY BIRD:—Larva, pupa and beetle.

Next in order, as Phylloxera enemies, may be mentioned the Lady birds (*Coccinella*), especially certain small, dark-brown species belonging to the genus *Scymnus*, and whose young, thickly covered with white and evenly-shorn tufts of a cottony secretion, are frequently found at their good work within the galls. Following these may be mentioned, as auxiliaries, certain Syrphus-fly larvæ, which, being blind, go groping about among the eggs and young lice which they seize and suck to death. Also certain orange larvæ of a smaller, two-winged fly (*Leucopis*); a few genuine bugs (*Heteroptera*) and notably the Insidious Flower-bug (*Anthocoris insidious*, Say, Fig. 14), and certain smaller Hymenopterous parasites.

[Fig. 12.]



b *a*

SYRPHUS LARVA.

[Fig. 13.]

SYRPHUS FLY.

[Fig. 14.]

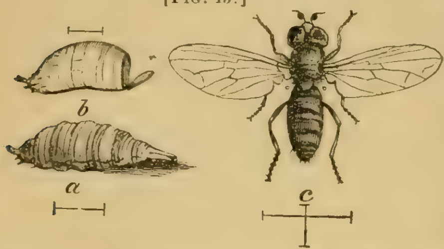
I

INSIDIOUS FLOWER-BUG.

* This is, at least, Dr. Fitch's supposition; but the fact that other insects, herbivorous by nature, have a similar habit, would indicate that it is more to protect the eggs from other cannibals; and the necessity for such protection, on the part of Chrysopa, is evident, since the eggs are usually placed among, or near, plant-lice, and these are always sought by many voracious enemies which would not hesitate to devour the Chrysopa eggs if they got a chance.

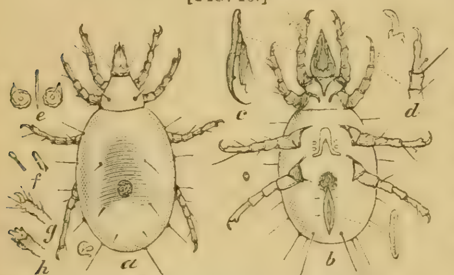
The enemies known to attack the Phylloxera under-ground are, naturally enough, fewer in number. In one instance I have found a Scymnus larva at the work six inches below the surface, and there is a Syrphus fly (*Pipiza radicum*, W. & R., Fig. 15), whose larva lives under-ground and feeds both on the Apple-tree Root-louse, and on this Grape Root-louse. Wonderful indeed is the instinct which teaches this blind larva to penetrate the soil in search of its prey; for the egg must necessarily be laid at the surface. But though the under-ground enemies of its own class are few, I have discovered a mite which preys extensively upon this root-inhabiting type, and which renders efficient aid in keeping it in check in this country. This mite (*Tyroglyphus phylloxeræ*, Planchon & Riley, Fig. 16,) belongs to the same genus (17) as the cheese and meal mites (*T. siro Linn.*), and the species (*T. entomophagus* Laboulbène) which infests preserved insects and is such a pest in cabinets. As is the rule with mites, it is born with but six legs, but acquires eight after the first or second molts. It varies considerably in form, with age, and in studying it with a view of distinguishing it specifically from other described species, I have noticed all the different tarsal characters shown as *d*, *f*, *g* and *h* (Fig. 16), and on which distinct genera have been founded. Mites present themselves in such different forms that the adolescent stages of the same species have been made to represent distinct families by authors who never studied the development of these beings. Thus the genera *Astoma*, *Leptus*, *Caris*, *Myobia*, etc., are now known to be but the larval forms, some of them commonly met with as such but not yet connected with the more perfect and mature forms. The different species of *Tyroglyphus*, so far known, prey on vegetal and animal substances, particularly when these are in a decaying or putrescent condition. In one of their forms (*Hypopus*) they are also known to be externally parasitic on living animals. The species under consideration combines both habits, as when young it mostly contents itself with the altered sweets of the roots which rot from the punctures of Phylloxera, while when older it preys by preference on the lice themselves.

[Fig. 15.]



ROOT-LOUSE SYRPHUS-FLY: *a*, larva; *b*, pupa; *c*, fly.

[Fig. 16.]



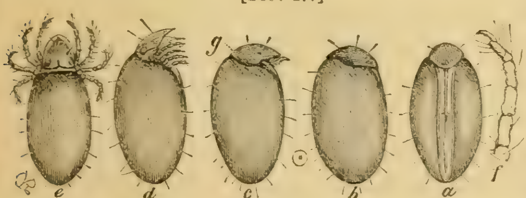
PHYLLOXERA MITE: *a*, dorsal; *b*, ventral view of female; *c*, mouth-parts; *d*, *f*, *g*, *h*, forms of tarsal appendages; *e*, ventral tubercles of male.

A singular feature in the life-history of many of the species of the genus *Tyroglyphus* is the fact that under certain conditions an entirely different form, with a hard brown chitinous covering or shield, and characterized by Dugès as a new genus by the name of *Hypopus*, develops within the softer body and finally issues from it by splitting open the softer skin. Claparède,* who believed this form to be the male, has carefully described and figured the process of change in the European *Hypopus Dujardinii*, and that *Tyroglyphus phylloxeræ* has its *Hypopus* form was independently proved by Prof. Planchon and myself—the letters announcing the observations on either side having crossed *en route*.

Hypopus, as already stated, has been found preying upon living animals. *Tyroglyphus* is a slow traveler, and with its soft body can not endure exposure to the air, or resist the attacks of other minute animals. Yet it is ubiquitous, living both above and below ground and swarming on decomposing animal and vegetal substances. When these have once been consumed or reduced to dry powder, what becomes of the swarming mites? M. Maguin has, I think, rightly answered the question. All adult and old mites, together with the young hexapod larvæ, perish; but those in the adolescent stage, the octopod pupæ, are preserved by their power of putting on a coat of mail which protects them against external influences until they can attach themselves to some living and moving animal, (flies, beetles, spiders, millipeds and larger animals), which become their carriers and transport them to places which they could otherwise never reach, and where, finding appropriate food, they throw off the disguise and breed as Tyroglyphs, with their well-known fecundity.

Associated with this predaceous mite, I have found another (*Hoplophora arctata* Riley, Fig. 17), of very curious form, reminding one strongly of a mussel; and I refer to it in this connection because I once strongly suspected it likewise to be, in some way, related to the soft-bodied Tyroglyphs. In studying these mites and their habits, I had frequently filled vessels with grape roots from which all but Tyroglyphs and Phylloxeræ had, to all appearance, been carefully excluded; only to find, on subsequent examination, a number of these mussel-like Hoplophoras and a corresponding decrease in the number of Tyro-

[FIG. 17.]



HOPLOPHORA ARCTATA: *a*, *b*, *c*, *d*, *e*, different attitudes assumed by it; *f*, strongly magnified leg.

Studien an Acariden, Leipzig, 1868.

glyphs. This happened more especially in the fall of the year, and I could not help suspecting that the former might prove to be a winter or hibernating form of the latter. There is so much yet to learn of the polymorphism of mites that the suspicion may yet prove justifiable. But with our present knowledge it is safest to explain the facts above stated on the ground that the Hoplophoras were at first buried, and consequently invisible, within the roots examined, and that the decrease in the number of Tyroglyphs was owing to death and other causes—an explanation which is all the more plausible from the fact that I subsequently found the same narrow-bodied Hoplophora swarming in decaying cottonwood logs.

Hoplophora (meaning armed or weapon-carrier) is an anomalous genus belonging to a curious family of mites (*Oribatidæ*), distinguished, as Nicolet well sets forth, from all other families by having a hard covering which is analogous to that of many hexapods, but less elastic or yielding, so that, while resisting a great degree of pressure, when it once gives way it cracks and fractures with the brittleness of glass. These coverings are differently formed and sculptured and frequently ornamented with protecting spines. The mites of this family are also distinguished from other mites by their organs of respiration which are at the superior base of the cephalothorax and look like eyes, being rounded elevations surmounted by a hair. The family comprises two great divisions: First, those which in the larva state have a form and appearance widely different from those of the adult, which are assumed only at the last molt. Second, those which are born more in the image of the adult form, to which they gradually approach by each successive molt. The genus *Hoplophora*, according to Nicolet, is further anomalous by being born with eight legs, whereas all other mites, even those of its own family, are born with but six; Claparède, however, shows that at least one species (*H. contractilis*) is hexapod before the first molt. Another peculiarity belonging to it is the mobility of the cephalothoracic shield which closes over the abdomen and fits tight like the lid of a box, whenever the animal withdraws its head and limbs, which it does on the slightest disturbance. Indeed, the hardened body-covering is admirably constructed for the purpose of protection. It is composed of three principal parts, the thoracic lid, a superior piece covering the back, the sides and the posterior portion of the body, and a ventral piece, more narrow, rounded behind, and divided in four by slits which form openings for the protrusion of the anal and genital organs.

The species under consideration differs from all others described in the form of the horny covering, which is so narrow that the animal topples over on its side the moment the limbs are withdrawn.

Since the discovery of this Phylloxera-feeding Tyroglyph in America, numerous sensational and exaggerated newspaper articles have appeared, glowingly describing how the French vineyards are to be saved from Phylloxera ravages by the introduction into France of this its enemy; and I have received several orders from Europe for supplies of the cannibal. Prof. Planchon, it is true, will attempt to introduce it, and we may hope with suceess; but from what is here said, it is evident that the enthusiasts who expect so much are doomed to disappointment.

Direct Remedies.—The leaf-lice, which do not play such an important part in the disease as was at first supposed, may be controlled with sufficient ease by a little care in destroying the first galls which appear, and in pruning and destroying the terminal growth of infested vines later in the season. The root-lice are not so easily reached. As the effort will be according to the exigency, we may very naturally look to France for a direct remedy, if ever one be discovered. But of all the innumerable plans, patented or non-patented, that have been proposed; of all the many substances that have been experimented with under the stimulus of a large national reward, no remedy has yet been discovered which gives entire satisfaction or is applicable to all conditions of soil. Nor is it likely that such a remedy ever will be discovered. A large majority of the remedies proposed, such as the planting of *Madia sativa* among the vines to catch the insect by its viscous property, or inoculating the vines with the essence of *Eucalyptus globulus*, are, upon their face, unworthy of practical consideration, or absurd. These we will pass by, and briefly mention only those which have been more or less productive of good.

Submersion, where practicable, and where it is total and sufficiently prolonged, is a perfect remedy. This is what even the closest student might expect, as he finds that excessive moisture is very disastrous to the lice. M. Louis Faucon, of Graveson (Bouche du Rhône) France, has abundantly proved its efficacy, and has, by means of it, totally annihilated the insect in his vineyard, which was suffering from it four years ago.(18) From his experience we may draw the following conclusions:

1. The best season to submerge is in autumn (September and October), when the lice are yet active and the vines have ceased growing. Submergence for 25 to 30 days, at this season, will generally rout the lice. 2. A submergence of 40 to 50 days, in winter, is required, and even where the water is allowed to remain during the whole of this season, the vineyard does not suffer. [I should consider this very doubtful.] 3. A vineyard should never be inundated for a longer period than two days in summer, or during growth; and though

these brief inundations at that season, affect only the few lice near the surface, and are by no means essential, they are nevertheless important auxiliaries to the more thorough fall or winter submersion, as they destroy the few lice which are always invading a vineyard in infested districts. These summer inundations will be necessary only after the winged insects begin to appear; and three or four, each lasting less than two days, made between the middle of July and the fall of the leaf, will effect the end desired.(19) 4. An embankment should be made around the vineyard in order that the water may evaporate and permeate the earth, but not run off and carry away any nutritive properties of the soil.

The varied success which has attended the different attempts to rout the enemy by inundation, is owing to the lack of thoroughness in many of them. The ground must be thoroughly soaked for a sufficient length of time. Temporary irrigation does not accomplish the end, for the reason that it does not reach all the lice, and does not break up the numerous air bubbles which form in the soil and prevent the drowning of many of the insects.

On our best hilly vine land, thorough submersion is impracticable; but on our bottom lands some of the grapes which fail now may be made to succeed by its means.

Of 140 different applications made by an intelligent and competent commission in the department of Hérault, France, most of the pure insecticides proved valueless. Many of them, such as carbolic acid, oil of cade, arsenious acid, sulphide of calcium, sulphide of mercury, arsenate of potash, etc., etc., will effectually kill the insect when brought in direct contact with it; but in field practice they can either not be brought in this direct contact, or else can not be used strong enough to kill all the lice without injuriously affecting the vine. Carbolic acid, added to water at the rate of about one per cent., applied by pouring into deep holes made by a crow-bar or auger, has given satisfactory results; and a thorough application of soot has also been strongly advocated by those who have tried it. In the experiments that I have been able to make in a small way, a thorough mixing with the soil of a cheap carbolic powder, has given good results.

The latest insecticide that has attracted attention and given great hopes in France, is the bi-sulphide of carbon. It seems to have been used as early as 1869 by Baron Thénard, but was brought prominently before the public last autumn by Messrs. Monestier, Lautand and d'Ortoman, who first proposed to introduce it at a great depth in the soil, so as to utilize its vapor. A vapor will naturally have the advantage over a liquid, as it will more effectually permeate the soil and

reach the lice. The simplest method of applying the sulphuret or bi-sulphide, is by making three holes, two or three feet deep, around the foot of the vine, then quickly pouring in the liquid and plugging them up. The holes may be made by a pointed bar driven by a maul About two ounces of the liquid to each of these three holes are recommended.

Soon after the announcement of this method, I employed it as a test on three vines which I knew to be infested with Phylloxera, using 3 oz. to the first, 6 oz. to the second and 9 oz. to the third—the soil being a light clayey loam. At the end of 12 days I found plenty of living lice on the first and second vines, and such were found long afterward, though in small numbers, up to the time of the freezing of the ground. On the third vine all the lice were evidently charred, but the vine was also evidently injured, as the leaves wilted as though they had been scorched, though whether from the vapor issuing from the ground or from the injury to the root, it was impossible to determine. I think, however, from the former, as the larger roots were yet alive late in the season, and the vine seems at this writing to be living. After very careful and laborious experiments made in France at different points and on different kinds of soil, by a commission especially charged with studying the action of this chemical, under the method proposed by Messrs. Monestier, Lautand and d'Ortoman, it fails to fulfill the sanguine expectations of these gentlemen. The liquid is costly, its application is laborious, and there is great difficulty in reaching and killing all the lice without injuring the vine. Great caution must also be had in its use, as it is extremely volatile and explosive—the vapor igniting at a great distance from the vessel containing it.

While, therefore, not very satisfactory results have followed the use of pure insecticides, the application of fertilizers intended to invigorate the vine and at the same time injure the lice, has been more productive of good. Especially has this been the case with fertilizers rich in potassic salts and nitrogenous compounds, such as urine. Sulphuret of potassium dissolved in liquid manure; alkaline-sulphates, with copperas and rape seed; potassic salts, with guano; soot and cinders, are, among other applications, most favorably mentioned.

Range of the Insect in America.—As already intimated, the insect is indigenous to the North American continent. I have been able to trace its existence, with absolute certainty, as far back as 1834; for in the herbarium of Dr. Engelmann there are specimens of *Vitis monticola* Buck. which were gathered that year in Texas by the botanist

Berlandier, and which have Phylloxera galls upon the leaves; while specimens of *riparia* in the same collection, and gathered in Missouri in 1845, also have the leaves disfigured by the same gall.

We find, in consequence, that the insect is very generally distributed over the States. I have myself found it in Kansas, Iowa, Illinois, Missouri, Michigan, Ontario, New York, New Jersey, Pennsylvania and Maryland, and have good evidence of its occurrence in Connecticut, District of Columbia, North Carolina, Texas, and as far south as Florida. It doubtless occurs in all the intermediate States. There is every reason to believe, however, that, like so many other animals which occur on the eastern slope of the Rocky mountains, but are unknown on the western slope, this Phylloxera is not indigenous to the Pacific half of the continent. I have, so far, been unable to trace its existence with any certainty in California; and to its non-existence there the Carlifornia grape-growers doubtless owe, in great part, their success in the cultivation of the European vine.

Yet I have strong evidence that around Sonoma (20) the insect already occurs, and has done much damage; and it may already have been introduced, either from the Eastern States or from Europe, into other parts of that country. It therefore behooves our friends of the Golden State to carefully look into this matter, and to endeavor, by taking the proper precautionary steps, to prevent a repetition of the disasters which have followed the introduction and spread of Phylloxera in Europe. Indeed, unless it shall turn out that their heavy winter rains protect them from its injuries, the grape industry of the Pacific coast is in great danger; and it might be well to follow the example of some of the Australian colonies which have passed acts of Parliament prohibiting the importation of vines from countries where the insect is known to occur. If this is not done, the utmost vigilance should be maintained in the inspection, by competent persons, of all imported vines.

Injury caused by Phylloxera in America.—In this country where, compared with Europe, land is so rich and abundant, we are apt to think lightly of injury to our crops, except when such injury becomes very great and wide-spread. It is a fact, long ago remarked by Dr. Fitch, State Entomologist of New York, that while in Europe the whole people become alarmed if a fifth of a given crop is destroyed by insects, the farmer here often thinks himself fortunate if he can save half the average yield from insect depredations. Vines have died year after year in our vineyards and very little notice has been taken of the fact; while certain varieties have continually failed until they have come to be discarded as unprofitable and useless. (21) Yet the

day is fast coming when the growing of superior varieties, which have for the most part failed, will alone be remunerative; and I believe that nothing will so tend to enable us to successfully grow them as a thorough knowledge of Phylloxera, which is in reality the principal cause of their failure.(22) Take as an instance the case of the Catawba. It is in growing demand in the Mississippi Valley, as, so far, the best white wine grape, and the only one extensively used in the manufacture of sparkling wines. Yet it is, in this part of the country, one of the most susceptible to the Phylloxera disease, and its successful growth becomes more and more uncertain. If, by a thorough understanding of the disease, and by the system of grafting which I have suggested, this vine can be successfully grown in the Mississippi Valley, it is safe to say that the value of our vineyards will be doubled; as the Concord, which is now the main reliance, and which makes but an inferior wine, has already so glutted our markets as scarcely to pay the grower.

Why the Insect is more injurious in Europe than here.—Without going into particulars, several good reasons may be given to explain the fact that Phylloxera is more devastating in the vineyards of France than in our own. There exists a certain harmony between the indigenous fauna and flora of a country; and our native vines are such as, from their inherent peculiarities, have best withstood the attacks of the insect. The European vine, on the contrary, succumbs more readily, not only because of its more tender and delicate nature, but because it has not been accustomed to the disease—there being, doubtless, a parallel between this case and the well-known fact that diseases and parasites which are comparatively harmless among peoples long accustomed to them, become virulent and often fatal when first introduced among hitherto uncontaminated peoples. Then the particular natural enemies of the insect which belong to its own class, and which in this country help to keep it within due bounds, are lacking in Europe; and it will require some time before the closely allied European predaceous species will prey upon and check it there to the same extent. The Phylloxera will, also, all other things being equal, have an advantage in those countries where the mildness and shortness of the winter allow an increase in the annual number of its generations. Finally, the differences in soil and in modes of culture have no insignificant bearing on the question in hand. Though Phylloxera, in both types, is found on our wild vines, it is very doubtful if such wild vines in a state of nature are ever killed by it. With their far-reaching arms embracing shrub and tree, their climbing habit unchecked by the pruner's knife, these vines have a corresponding length and depth of root, which render them less susceptible to injury from

an under-ground enemy. Our own method of growing them on trellis approaches more nearly these natural conditions than that employed in the ravaged French districts, where the vines are grown in greater proximity and allowed to trail on the ground, or are supported to a single stake. Their soil is also, as a rule, poorer than ours.

FALSE THEORIES.

It requires less time to make a false statement than to refute it, and there will ever be those who prefer to theorize and jump to conclusions, rather than ascertain facts by the more tedious and laborious inductive method. There exists a certain popular love of the mysterious—a willingness to rest with the vague and indefinite—which readily gives support to the wildest notions of things, especially if they be bruited about with a flourish of rhetoric and a semblance of reason.

The history of Phylloxera is a repetition of the history of many other like diseases. The hard and more weighty facts lay at first hidden by ignorance, and had to be jostled, by active investigators, through a superincumbent mass of opposing views and theories, which have either sunk out of view, or been washed away by the resistless force of truth. Many of these theories are too absurd to be noticed, and I shall only briefly consider those which have, or have had, more or less influence with intelligent persons. Ever since the day when Planchon discovered the real cause of the Phylloxera disease in France, in the insect now known by that name, there has been a class of writers who have strenuously contended that the insect is the effect and not the cause of the disease. As a rule, the reasons given in support of this view are about as philosophical as that of the darkey who, being asked by his master why the sun goes to the south in the winter, replied: "Well, I don't know, massa, unless he no stand de 'clemency of de norf, an' so am 'bliged to go to de souf, where he speriences warmer longimitude!" In spite of the facts that the insect precedes but never follows the rotting of the roots; that it congregates on the most vigorous and succulent portions; that it is always cöexistent with the disease, and is not found in the unaffected vine districts; in face of the demonstrable hurtfulness of its puncture, and the isolated spots or centers of attack from which the disease often originates, and of the fact that total and prolonged submersion is an effectual cure—men still have the hardihood to compare it to scrofula in man; to attribute it to "divers circumstances," "meteorological perturbations," "pathological conditions of the vine," "superabundance of sap too suddenly arrested by atmospheric influences," etc. etc. The arguments are unsatisfactory and the explanations negative and vague, yet the partisans of these views number among them some

good entomologists, as Signoret, Boisduval and the late Guérin-Méneville—men, however, whose records have earned for them the title of impractical. When the Oidium first began to attack French vines the last-named gentleman maintained that it had nothing to do with the injury now so well known to be caused by it; but argued that the vines were simply diseased from plethora of sap. So of that fearful silk-worm disease known as *pébrine:* long after the laborious and painstaking Pasteur had analyzed it and shown that it is due to the presence and multiplication of certain corpuscular *psorospermiæ*, Guérin-Méneville insisted that no importance could be attached to the presence of these bodies. It is not surprising, therefore, that he should have persisted in misconstruing the facts regarding Phylloxera, and in believing that it is a "pathological condition of the vine which has favored the increase of the insect." Yet the practical grape-grower of to-day aims his sulphur remedies direct at the Oidium fungus, knowing well that if he can prevent its multiplication he will prevent the disease; while the silk-grower labors for the prevention or destruction of the *psorospermiæ*, knowing that without them his worms will not suffer from *pébrine.* And so it will be with Phylloxera: keep off or destroy the insect and you avoid the disease. We have in all such cases a repetition of the noted itch controversy. For centuries the work of *Acarus scabiei* was supposed to be a constitutional malady, due to "thickened bile," "drying of the blood," etc., and long after Dr. Bonomo gave us its true rationale, there were not wanting those who denied any connection between the mite and the disease, or who explained the presence of the former by abiogenesis, or by other equivocal means.

The more plausible arguments that the Phylloxera disease is caused by drouth, by too long continued cultivation of the same plant from cuttings, too severe pruning, exhaustion of soil, etc., have all of them fallen before the facts; and the poor grape-grower who, influenced by them and regarding the Phylloxera with indifference, was led to replace his dead vines by others, has been bitterly disappointed in seeing these in time destroyed and his labor and outlay lost.

If there were no other proof of Phylloxera being the cause of the disease than that which I have lately obtained, it would be overwhelming in contrast with the non-experimental views of the opposite school. Conceiving that the question could be settled by a very simple experiment, I planted in pots, in the spring of 1873, four one-year rooted Catawba vines, all of a size and vigor, and the roots of all ascertained to be free from Phylloxera. Two of these vines were, during the summer, kept out of the reach of infection; while, from time to time, I buried, in the other two pots, pieces of roots heavily

charged with Phylloxera in all stages. The result has verified my anticipation: the infected vines became sickly, and passed through the conditions already described, which indicate the disease. After a brief period of rest, late in the fall, I brought all the vines in a warm room. The infected vines are now dead, and an examination showed their roots rotted and wasted; the non-infected vines are living and growing finely. To the same effect is the experience of Mr. Malcolm Dunn, a gardener of Powerscourt, Ireland, who, finding that the vines in his grapery were suffering from Phylloxera, uprooted them and carefully cleansed the roots and freed them of the insect. After replanting in new earth he had the pleasure of seeing the vines regain their vigor. "I am the last to deny that meteorological conditions accelerate or retard the multiplication of plant-lice, as they do of so many other insects; but I see no reason for presupposing a diseased condition of the plant first attacked by them, when, as every entomologist knows, they can flourish only on living vegetation, which they forsake when its life has been sapped. Conditions may be favorable to the increase of the plant-lice on our hops, of cotton-worms, of the Army-worm, and of a thousand well-known insect pests; yet no one doubts that if, by increased effort, we, in some way or other, prevent or destroy these insects, we effectually overcome the (to us) unfavorable conditions, and our plants thrive.

"Whenever abundant enough to attract attention, these plant-lice have already brought the infested plants into a state of disease, and it is this fact which blinds so many persons, and makes them so ready to believe that it was the diseased condition which attracted, or as some more ignorantly put it, produced the lice."* That conditions of soil and atmosphere may favor or retard the multiplication of Phylloxera, will not, therefore, be doubted by any one; but that an insect which thrives most on the more vital and growing parts of the plant shows, in the winged state, a preference for a weak vine over a healthy one, is in itself highly improbable; while the supposition that the wingless form, in its spread from vine to vine, shows any such preference, is entirely groundless.

Again, another set of writers maintain that the insect is not American, and that it has always existed in France, and is autochthonous wherever found. The facts already presented will, I hope, sufficiently refute this theory. We might naturally infer, *a priori*, that the insect was imported into Europe; for it requires a great stretch of imagination to suppose that it had remained dormant and unnoticed for centuries, to suddenly appear in several different and

*5th Rep., p. 68.

widely separated localities; but inference becomes certainty when we find that it is indigenous to America, where its dissemination is general over the country, within certain limits; that its origin in Europe may be traced to points where American vines were introduced; and that its spread there from place to place has been carefully recorded, and still continues. It is not likely that all American vines imported into Europe have carried with them the insect; but the fact is fully established that it has spread, whether in France, Austria or Portugal, from centers where American vines have been grown—a fact of the utmost significance. Intercourse between countries has always brought with it an interchange of products, whether intentional or otherwise. As a rule, the stream of the unintentional importations has been from east to west, and Europe has given to America many more noxious weeds and insects than it has received from us. Yet the European cultivator must charge us with a few of his very worst pests, among which may more especially be mentioned the *Oidium Tuckeri*, the *Erigeron Canadense*, the *Eriosoma lanigera*, and the *Phylloxera vastatrix*.

The suppositions of M. Koressios, of Athens, Greece, and of M. Nourrigat, of Lunel, France—the former considering it the *Phtheir* of the Greeks, the latter the disease called "Gabel" by the Germans—have been demonstrated by Prof. Planchon to be false. The *Phtheir* is a mealy scale insect (*Dactylopius longispinus*), existing now, as it did in the time of the ancients, on the Vine, both above and below ground, in the Mediterranean region. It does much injury to vines in the Crimea. The "Gabel" is altogether another malady, not caused by insects.

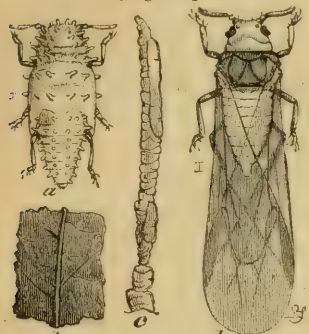
Other writers have maintained that the soil is full of Phylloxera, and that it occurs on all sorts of fruit trees. The Grape Phylloxera is peculiar to that plant as a genus, and all the rumors of its infesting other plants, or fruit trees, have been proved to be false, and arise from the inability of the observers to distinguish between different species and genera of root-lice. (23.)

Finally, since the discovery of Phylloxera on the roots of our American vines, there have not been wanting those who either deny its existence, or who put forth the more sophistical argument that injury to our native or foreign grape-vines does not result from its work, but is to be attributed to fungus growths. (24.) Others again believe that fungus growths, such as mildew, are indirectly caused by the injury done by Phylloxera to the roots. Without denying that vines sometimes suffer from fungus growths independent of Phylloxera, and without expressing any opinion as to whether the insect is in any way concerned in the growth of these funguses, I can safely

assert, and I think the facts here set forth will bear out the assertion, that our vines languish or die more often from Phylloxera than from any other cause, whether in connection with or entirely independent of cryptogamic plant growth.

THE AMERICAN OAK PHYLLOXERA—*Phylloxera Rileyi* Lichtn.

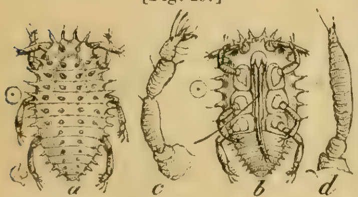
[Fig. 18.]



PHYLLOXERA RILEYI:—*a*, pupa; *b*, winged female; *c*, antenna greatly enlarged; *d*, portion of infested leaf, underside.

There are several described and undescribed species of Phylloxera in this country, most of them inhabiting leaf-galls made on our different hickories. The species herewith figured is the only external feeder known in America, and is briefly alluded to in this connection to show that, as with the Grape Phylloxera, it does not need a "winter egg" to enable it to hibernate, but passes the winter in the larva state, (as at Fig. 19), firmly attached to the tender bark of the younger twigs and thus braving all the vicissitudes and inclemencies of that season. In the summer it is found on the under surface of the leaves of the White and Post oaks, in the wingless female state of all sizes. Soon after it is born it inserts its beak into the leaf-tissue, and becomes more or less stationary. It causes no swelling of the leaf, but a yellow circular spot (Fig. 18, *d*) somewhat larger than its own body and showing most plainly on the upper surface. The eggs are laid singly around the louse, and the process of parthenogenetic reproduction goes on for several generations, as in the Grape Phylloxera. By about the end of August, when these lice and their eggs are often very numerous, and when the speckled and often withered appearance of the leaf easily betrays their presence, the winged individuals begin to appear.

[Fig. 19.]



PHYLLOXERA RILEYI:—*a*, *b*, dorsal and ventral views of larva as seen hibernating; *c*, *d*, highly magnified leg and antenna of same.

This species is at once distinguished from all other American species, so far known, by its slender form and small size, but particularly by the long tubercles of the larger apterous individuals, and of the pupæ (Fig. 18, *a*.) Otherwise it greatly resembles the Grape Phylloxera in color, and in the different forms it assumes, and for more detailed descriptions I refer the reader to the appendix. (25.) In habit and general appearance it very closely resembles the European Oak Phylloxera; but differs remarkably in its winter habit from what

has hitherto been recorded of this last species, in that the last hatched larvæ in the fall fasten themselves to the more tender oak twigs, where they rest till the following spring, with scarcely any change except in the deepening of the color, which, as in the young Grape Phylloxeræ hibernating on the roots of its food-plant, becomes deeper and acquires a yellowish, or even a reddish-brown tint. (26)

As the leaves begin to put forth, our young Oak Phylloxeræ cast off their winter skin, and their lethargy with it. They may then be seen crawling up and down the twigs, but do not settle on the leaves. Attaining, in a few days, full growth, they begin a virginal reproduction by covering the twigs with eggs, which hatch in just about a week if the weather is warm and propitious. Thus the hibernating lice acquire their growth, and give birth to the first generation, in the short space intervening between the opening of the buds and the full growth of the first leaves. Beyond this I have not yet traced the vernal history of the species.

CONCLUSION.

We have in the history of the Grape Phylloxera, the singular spectacle of an indigenous American insect being studied, and its workings understood in a foreign land, before its presence in its most injurious form was even suspected in its native home. The Franco-Prussian war, with all its fearful consequences to France, has passed away; the five milliards of francs (one thousand million dollars) have been paid as indemnity to her victors, in so short a time that the civilized world looked on in wonder and astonishment. Yet this little Phylloxera, sent over, doubtless in small numbers, by some American nurseryman, a few years since, continues its devastating work, and costs that unfortunate country millions of francs annually. The last German soldier has been removed—at terrible cost it is true—from French soil, but the Phylloxera army remains; and if another five milliard francs could extirpate the last individual of this liliputian insect host from her soil, "la belle France" would be cheaply rid of the enemy. Had the world, twenty years ago, possessed the knowledge we at present have of this insect and of its dangerous power, a few francs might have originally stayed its invasion of that great vine-growing and wine-making country. Needs there any more forcible illustration of the importance of economic entomology!

APPENDIX.

(1) The present Minister of Agriculture and Commerce has quite recently placed a special resource of 20,000 francs to the credit of the Academy of Sciences at Paris, to defray expenses of studies and experiments to be made in 1874 under the directions of said Academy.

(2) The following specific diagnosis of the mature forms, drawn up from our American insect, (thousands examined), will, I hope, forever quiet the skepticism of those who believe it different from the European species, by enabling them to make the most careful comparisons. The immature characters have been sufficiently detailed in the text:

DIAGNOSIS OF PHYLLOXERA VASTATRIX.

TYPE 1. *Gallæcola* (*vitifoliæ*, Fitch)—

Average length 0.04 inch; nearly as broad. Form broadly ovoid. Surface granulated, superiorly with rows of short hairs in place of the tubercles of Type 2, inferiorly with three pairs of pale, fleshy, medio-ventral tubercles between the legs, the anterior pair smallest, and three dusky and but slightly raised sub-ventral warts each side, just outside the legs, (two of them between the first and second legs, the first nearly equidistant between them, the second close to second leg, and one between the second and third legs). Members short and imperfect, the antennæ granulated and with but one corneous plate, more or less circular in form, and near the tip. Eyes composed of three simple eyelets. Tarsi imperfectly 2-jointed, the digituli imperfect; the claws more or less imperfect and not horny. Color of body dull orange-yellow; more dusky at upper anterior end. Legs, antennæ and proboscis more dusky, inclining to black. Insections of thorax imperfect. (Fig. 4, *f*, *g*, *h*.)

TYPE 2. *Radicicola*—

a. Degraded or Wingless Form.—Differing from the preceding only in the somewhat stouter members, more pyriform body, and in having superiorly series of more or less distinct warts or tubercles, which, like the members, are more dusky than the general color of the body. The body is more or less distinctly insected and tubercled superiorly as follows: The head forms one division and has 10 tubercles—4 medio dorsal and quadrangularly arranged, 3 lateral and arranged around the eyelets, one of them usually subobsolete; the prothorax is more or less distinctly divided transversely in two, with 6 tubercles in a transverse row in each division, (or 12 in all), the second from outside more or less obsolete; the mesothorax with 8 tubercles, 4 dorsally in a transverse line, and 2 laterally in a longitudinal line; metathorax distinctly divided in two—the first half with 8 tubercles as on the mesothorax, the second with 6 as on the prothorax, or 14 in all; the abdomen with 7 joints and a subjoint, and each joint with but 4 transverse tubercles, except the 7th, on which they are either obsolete or form but a dusky mark. Besides these tubercles, there are on each of the thoracic insections about 6 more or less distinct dark points, and 2 or more on the head;

while subventrally a row of 4 or 5 such points are sometimes visible on the larger abdominal joints. (Fig. 5, *f*, *g*.)

β. *Perfect or Winged Form.*—Wings membranaceous and slightly fuliginous. Body non-tubercled, of a brighter yellow color. Thorax with an encircling broad, dusky band; the mesosternal plates darkest; the more corneous parts very finely striate, the softer parts slightly rugose. Eyes large, with rounded facets; deep reddish-brown. Three ocelli, two between the antennæ and the eyes, and one in front between the bases of the antennæ. Antennæ long, with the third joint showing two constrictions, and generally two corneous plates, the terminal more elongated than the other. Legs long, the two joints of tarsus distinct, and the digituli more or less perfect. Rostrum reddish at base. The most numerous individuals, which are females, almost thrice as long as broad, slightly constricted behind the thorax; the wings extending half their length beyond the tip of the abdomen, and having their veins indistinct, straight and disconnected (Fig. 7, *a*). A few, the true nature of which is yet problematical, somewhat smaller, with the body only half again as long as broad, the thoracic band paler; and the mesosternal plates, antennæ, legs and wings all proportionally larger and stronger, the wings with the veins more distinct and curving and anastomosing at base (Fig. 7, *b*).

This diagnosis might be greatly extended in detail by the enumeration of other characters which are, however, variable, and are sufficiently indicated in the figures. By virtue of a series of minute and transverse wrinkles at the hind portion of the abdominal joints (Fig. 5, *j*) and the natural elasticity of the chitinous covering, the abdomen is quite tractile, so that other forms but those enumerated, and some of them intermediate, may be distinguished by those who study only individuals. The length of proboscis is variable, as, indeed, are most of the characters given, even to the wing-veins; while the constrictions in the third joint of the antennæ sometimes give that organ the appearance of being either 4 or 5-jointed. The *tout-ensemble* of the species will not however, present other permanent forms than those given. The tubercles on the head are frequently so close together and indistinct as to give the body here a much more dusky appearance than elsewhere; and I have examined specimens where the tubercles over the whole surface were so spread out that they were distinguished only by intervening paler lines.

(3) So great is the tendency of the down to increase under the influence of the insect's puncture, that I have seen the tips of roots, especially when at the surface of the ground, quite tomentose under its influence, though such roots are normally either quite smooth or very sparsely supplied with fine hairs.

(4) Dr. Shimer, in his paper already cited, describes what he took to be the male, but he gives no proof of its masculinity, and there is cumulative evidence to show that the few specimens he found (four winged specimens and three pupæ out of ten thousand galls examined) were from the roots; for these, in the pupa and winged states, may occasionally be found wandering over the vines; and in all my examinations I have never found any pupæ or winged insects that I could confidently believe were produced from the type *gallæcola*.

(5) This fact can not be too much insisted on. In the early history of the insect in this country, when it was known only in the gall-inhabiting type, I recommended the destruction or non-cultivation of the Clinton and its allies because of their liability to the attacks of the gall-louse. In the light of our present knowledge, the gall-louse is

not worth considering in a vineyard known to be suffering from the root-louse, and it need only be watched for, and if possible checked, in a young vineyard into which it is desired to prevent the introduction of the pest.

(6) Thus, in 1870, they were very abundant on the Clinton in all the Eastern and Middle States, while in 1871 and 1872 they were almost unnoticed on the Clinton, and had become more numerous on the Taylor. In the early part of the last-named year it was absolutely impossible to find a gall in the vicinity of St. Louis, where they had been so abundant two and three years before; while late in the season the few met with were mostly on the Delaware, with abortive attempts to found them on Herbemont and Concord. So in 1873, the only galls I found early in the season and in sparse numbers were on Marion, there being none on some Clintons that were in the vicinity. Later in the year a few were found on Golden Clinton, Marion and Blue Dyer, on the last of which they were mostly abortive. In August I saw a few on Clinton in the Eastern States, and they have been reported to me from Kelley's Island, O., and Hammondsport, N. Y., and to Dr. Wm. LeBaron from Neponset, Ills.*

(7) These tubercles may sometimes be traced, especially in the hibernating larva, before the first molt, and are generally quite distinguishable after the first molt. In some individuals, again, they are scarcely visible till after the second molt.

(8) I do not mean to be understood, in making these distinctions, that these differences of form are so constant that they can always be relied on; for the form of the body varies so that the wingless mother insect may present the more perfect oval of that destined to become winged. But, as a rule, these differences are observable, and small and variable as they are, I know of no others by which the winged and wingless forms can be distinguished in early life, though I have diligently sought for some distinction.

(9) In August, near the surface of the ground, on the roots of 2-year old Clinton vines having a few galls on the leaves, I have taken full-grown individuals with such faint traces of these warts that, with a lens only, such lice could not be distinguished from *gallœcola*.

(10) Signoret, in speaking of *Ph. quercus*, referred, in 1867, to the smaller individuals as ♂'s (*Ann. de la Soc. Ent. de France* 1867, p. 303); but in recently speaking of these smaller individuals, supposed to be ♂'s by others and myself, he declares they are nothing but females emptied of their eggs. Yet in referring to the specimen which, as stated (Rep. 5, p.71), I sent him for examination at his request, he confesses that neither he nor Balbiani could decide the question; but after soaking the specimen in water with a small proportion of alcohol and potash, he *thought* he could decide it to be a female, also with the abdomen emptied of eggs (j'ai cru pouvoir décider que j'avais, sous les yeux une femelle ne différant en rien de celles de France). Thoughts and suppositions ought not to give birth to positive declarations, and, whatever the nature of the specimen sent to M. Signoret, I have many reasons for believing that the abdomen had never been emptied of eggs.

I should attach little value to the shorter, more contracted form, were it not noticeable in the pupa; or even to the peculiar anastomosing wing-venation, which varies somewhat, and may be exceptionally found more or less perfect in the females. But the vesicles can scarcely be taken for immature eggs, because they are always more numerous than the eggs in the abdomen of the winged female, (I have not found more than five in these, and there are more often but two or three), and present different characteristics.

*Prairie Farmer, Sept. 13, 1873.

(11) There is matter of dispute among authors as to the number of generations annually produced, and it is difficult to ascertain the number. I have, however, experimentally proved by artificial breeding this winter, that at least five generations may follow each other without the appearance of form β which is destined to become winged. I have kept, in large darkened vases, a number of Phylloxeræ feeding and breeding on Clinton roots, which, from the tendency to sprout, furnish sufficient nourishment without requiring very frequent renewal, if kept lightly mixed with moist soil. These lice were taken in November when in the hibernating larval condition, in which they would be the following spring when they naturally awaken from their torpor and commence multiplying. Though kept in my office, in which the temperature was only comfortably warm during the day, and sometimes sank nearly to about freezing point during the night, they have continued to grow and multiply. In order to ascertain the exact number of generations that followed each other, I separated some of the first deposited eggs, and placed them in glass test-tubes, partly filled with earth, and furnished with short but thick pieces of Clinton root. As soon as the lice from these eggs became mothers and laid, their first eggs were again separated, and this process went on till, on the first of April, when plant-life was still dormant out-doors, I had the fifth generation of lice, which, owing to the adding of too much moisture to the tubes, died and rotted, and thus prevented the continuation of accurate notes. On the third of April, however, in examining the large vases, several pupæ were met with, and on the 10th of the same month I had winged females in my office, when, on account of the lateness of the season, and as I know from actual observation, the insects out-doors had not yet awakened from their winter lethargy.

Signoret, in his first work on "*Le Phylloxera de la Vigne*" (*Ann. de la Soc. Ent. de France*, 1869, p. 575), referred to the rapid multiplication of the Aphides, repeating the well-known statement that at least nine generations are produced in the space of three months. Yet he has lately (*Comptes Rendus de l'Ac. des Sc.*, Aug. 4, 1873) endeavored to make out that there are but about two generations in the course of the year. In reality the eggs often hatch in warm weather within a week after deposition, and the lice commence depositing at this season, when they are 10 or 12 days old—the rapidity of increase depending on the temperature, and the process coming to a stand-still in winter.

Similarly, there has been some dispute as to the number of molts which the individual undergoes, and Signoret (*loc. cit.*) by an unwarrantable mixing and fusing of two distinct generations, makes out no less than six. In the mother form (a) of *radicicola*, there are but three molts, as recorded by Cornu, and as I have repeatedly proved this winter, by enclosing a single newly-hatched louse in a tight glass tube along with a piece of root first carefully examined to see that no other lice or exuviæ were upon it. By the time such an individual has become a mother and attained maturity, three distinct cast-off skins will be found in her immediate vicinity, if she has not been disturbed during growth—the skins adhering to the root by the outstretched and forsaken leg-coverings. Cornu has found the same number (three) of exuviæ in the leaf galls, thus indicating, as would be expected, that *gallæcola* goes through the same number of molts as its root-inhabiting analogue. It is possible that the winged form undergoes more than three molts, though there have been no definite observations on this point, as they are necessarily difficult.

(12) Throughout the winter I have been placing young root-lice, as they hatched, upon the newly forming leaves of some potted Clintons, Delawares and Eumelans grown for the purpose. On the 17th of January, after an absence of four days at Hannibal, I was fairly delighted by the discovery of a solitary, partially formed gall on one of the lower leaves. It must necessarily have been formed by a young root-louse, either from those placed on the leaves, or from those hatched on the roots of the same vine; for the

season precluded the possibility of any true gall-lice being about. I watched from day to day, hoping to see this precious gall grow, and expecting soon to see others, until at the expiration of three week, noticing no change, I began to fear that it was aborted, and on subsequently plucking the leaf and examining it, it unfortunately proved so to be. I have since continued to place young root-lice, of different generations, on the most inviting leaves, but have obtained no more galls. Unsatisfactory as this isolated experience is, it is, nevertheless, highly interesting, and proves that while the young root-lice are very reluctant to settle on the leaves, and seem incapable of producing galls, certain individuals among them can do so.

(13) For a very minute and careful study of the patholcgical characteristics of these swellings, the reader may refer to Maxime Cornu's excellent papers in the *Comptes Rendus*, for 1873, and *Mémoires* (xxii, No. 6) of the *Académie des Sciences*, Paris. He corroborates, by detailed observations, the conclusions previously arrived at by Planchon and his followers; but, like too many of his countrymen, very generally ignores observations made out of France, and consequently sometimes repeats as original, facts recorded elsewhere with less of detail. He concludes that the Phylloxera is not nourished by the sap of the plant, but by plasmatic material which the latter stores up. He also concludes that the swellings are produced solely by the mechanical action of the tongue, and that they in themselves are the cause of the trouble, by absorbing in their development, the nourishment needed for the vine, and by affecting, in rotting, the parts not touched by Phylloxera: in other words, that the amount of nourishment appropriated by the lice would never seriously affect the vine, were it not for the characteristic and intrinsic swellings. I can not accept the last two conclusions. There is a strong *a priori* probability that the swellings are due to something more than mere mechanical action—to some poisonous excretive fluid, as in many gall-flies (*Cynipidæ*) and saw-flies (*Tenthredinidæ*); or to some irritating and poisonous property of the proboscis, as in the spines and hairs of many larvæ. We may not be able to analyze it, but it is difficult to understand how, without some such poisonous property, the Phylloxera leaf-gall is developed, while so many other plant-lice perform similar mechanical acts to that performed by Phylloxera without causing abnormal growths on the plants they infest. Bearing in mind also, the withering and blasting effects which many plant-lice and bark-lice cause to plants which never swell abnormally from their punctures, it would seem obvious that with the vine roots covered with Phylloxera, most of them rapidly developing and multiplying, the direct loss of plant substance must be very material—however great the indirect loss through the swellings may be. There are any number of plant-lice no larger than our Phylloxera, and which there is every reason to believe appropriate no more for the nourishment of their bodies, which nevertheless affect most seriously the plants they inhabit by direct sucking of the plant juices.

(14) THE TRUE GRAPE-VINES OF THE UNITED STATES.

BY DR. G. ENGELMANN.

The Grape-vines are among the most variable plants, not only through cultivation by which numberless varieties have been produced, but even in their wild state, in which climate, soil, shade, humidity, and perhaps also natural hybridization, have originated such a multiplicity and such an intermixture of forms, that it is most difficult to recognize the original types and to refer the different given forms to their proper alliances. Only by carefully studying a large number of forms from all parts of the country, in their peculiar mode of growth, and especially their fructification, or

rather their seeds, are we able to arrive at any thing like a satisfactory disposition of these plants.

Before I proceed to the classification of our Grape-vines, I deem it necessary to say a few preliminary words:

All the true Grape-vines bear fertile flowers on one stock, and sterile flowers on another separate stock, and are, therefore, called *polygamous*, or not quite correctly, *diœcious*. The sterile plants do bear male flowers with abortive pistils, so that while they never produce fruit themselves, they may assist in fertilizing the others; the fertile flowers, however, are real hermaphrodites, containing both organs in perfection, and capable of ripening fruit without the assistance of the male plants. Real female flowers, without stamens, do not seem ever to have been observed. Both forms, the male and the hermaphrodite, or if preferred, those with sterile and those with complete flowers, are found mixed in the native localities of the wild plants, but only the fertile plants have been selected for cultivation, and thus it happens that to the cultivator only these are known, and as the Grape-vine of the Old World has been in cultivation for thousands of years, it has resulted that this hermaphrodite character of its flowers has been mistaken for a botanical peculiarity, by which it was to be distinguished, not only from our American Grape-vines, but also from the wild grapes of the Old World. But plants raised from the seeds of this, as well as of any other true Grape-vine, generally furnish as many sterile as fertile specimens, while those produced by layering or cuttings, of course only propagate the individual character of the mother-plant.

The peculiar disposition of the tendrils in the Grape-vines, first indicated by Prof. A. Braun, of Berlin, furnishes an important characteristic for the destinction of one of our most valuable species, *Vitis Labrusca*, and both its wild and cultivated varieties, from all others. In this species—and it is the only true *Vitis* exhibiting it—the tendrils, or their equivalent, an inflorescence, are found opposite each leaf, and this arrangement I designate as *continuous tendrils*. All the other species, known to me, and even *Vitis Thunbergii*, the east Asiatic representative of our *V. Labrusca*, often thrown together and confounded with it, exhibit a regular alternation of two leaves, each having a tendril opposite it, with a third leaf without such a tendril, and this arrangement may be named *intermittent tendrils*. Like all vegetative characters, this is not an absolute one: to observe it well, it is necessary to examine well-grown canes found in spring, and neither sprouts of extraordinary vigor nor stunted autumnal branchlets. The few lower, smaller leaves of a cane have no opposite tendrils, but after the second or third leaf the regularity in the arrangement of the tendrils, as above described, rarely fails to occur. In weak branches we sometimes find tendrils irregularly placed opposite leaves, or, sometimes, none at all.

It is a remarkable fact, connected with this law of vegetation, that most Grape-vines bear only two inflorescences (consequently two bunches of grapes) upon the same cane, while in the forms belonging to *Labrusca* there are often three and, rarely, four in succession, each opposite a leaf. Whenever, in rare cases, in other species, a third inflorescence occurs, there will always be found a barren leaf (without an opposite inflorescence) between the second and third ones. Most species belonging to *Cissus* exhibit the same arrangement, but a few are known to bear consecutive tendrils, just as *V. Labrusca* does.

Young seedlings of all the Grape-vines are glabrous or only very slightly hairy. The cobwebby or cottony down, so characteristic of some species, makes its appearance only in the older or in the adult plants; but in some of their varieties, and not rarely in the cultivated ones, it is mainly observed in the young growth of spring and is apt to disappear in the mature leaf; but even then the leaf is never shining as it is in the glabrous species, but of a dull or unpolished appearance.

The form of the leaves is extremely variable, and descriptions must necessarily remain vague. Leaves of seedling plants are all entire, i. e. not lobed; young shoots from the base of old stems, as a rule, have deeply and variously lobed leaves, even where the mature plant shows no such disposition. Some species * or some forms of a few species † have all the leaves more or less lobed, while others exhibit on the mature plant only, entire, or, I should rather say, *not lobed* leaves. Only the leaves of flower-bearing canes ought to be considered as the normal ones.

The surface of the leaves is glossy and shining, and mostly bright green; or it is dull above and more or less glaucous below. The glossy leaves are perfectly glabrous, or they often bear, especially on the nerves of the lower side, a pubescence of short hair. The dull leaves are cottony or cobwebby, downy on both or only on the under side; and this down often extends to the young branches and to the peduncles, but as has been stated above, often disappears later in the season.

One of the most distinctive and permanent characters of the Grape-vines is found in the seeds. The berries may be larger or smaller, of different color and consistency, and contain fewer or more seeds (never more than four), but the seeds, though to some extent variable, especially on account of their number and mutual pressure, where more than one‡ is present, exhibit some reliable differences. The big top of the seed is convex or rounded, or it is more or less deeply notched. On the inner (ventral) side are two shallow longitudinal depressions. Between them is a slight (where there are one or two seeds) or a sharper (where the seeds are in threes or fours) ridge, along which the raphe (the attached funiculus or cord) is noticed running from the *hilum*, at the lower, thin end of the seed, along this ridge over the top of the seed, and ending on its back in an oval or circular well-marked spot, called by botanists *chalaza*. This raphe is either indistinct, scarcely perceptible, or it is more or less prominent, like a stout thread, especially where it crosses the top of the seed. In our American species these characters seem pretty reliable, but in the varieties of the old world Grape-vine (*vinifera*), several thousands of years removed from their native sources, the form of the seed has also undergone important modifications, and can no longer be considered such a safe guide as in our species.

It is interesting to know that since the times of Linnæus and of Michaux, not a single real species has been added to those belonging to the territory of the old United States, east of the Mississippi river, though Rafinesque, LeConte, and perhaps others, have attempted to distinguish and characterize a great many more; while Director Regel, of the St. Petersburg botanic garden, has lately attempted, rather unnaturally, to contract them and to unite them with old world species—*Vitis vinifera* resulting, according to his views, from the hybridization of several of these species.

The number of true Grape-vines (bearing edible fruit) in the present territory of the United States, considered good species, is limited to nine, which, according to their economical value, may be enumerated thus:

I. Grape-vines which have yielded our different cultivated varieties:

1. Vitis Labrusca, Lin. Northern Fox Grape.
2. Vitis æstivalis, Michx. Summer Grape.
3. Vitis riparia, Michx. Riverside Grape.
4. Vitus vulpina, Lin. Southern Fox or Muscadine.

* *Vitis riparia.*

† Forms of *Vitis Labrusca* and of *Vitis æstivalis.*

‡ A single seed is always thicker, plumper, more rounded; two seeds are flattened on the inner, rounded on the outer side; three or four seeds are more or less angular; these different variations may sometimes be found in berries of the same bunch.

II. Grape-vines of less Consequence which thus far have given no cultivated Varieties:

5. VITIS CANDICANS, Engelm. Mustang Grape of Texas.
6. VITIS CORDIFOLIA, Michx. Winter or Frost Grape.
7. VITIS CALIFORNICA, Benth. Confined to California.
8. VITIS ARIZONICA, Engelm. Similar to the last.
9. VITIS RUPESTRIS, Scheele. Bush-Grape or Sand-Grape.

In treating of the practically useful American Grape-vines, we are principally concerned with the first four species; but in order to properly characterize these, I have to give a synoptical table of all our species.

I. Grape-vines with loose shreddy Bark, climbing by the aid of branched Tendrils, or (in No. 4) often not climbing at all:

a Berries small, 3–6 or rarely 7 lines in diameter; seeds obtuse, with the raphe (or cord) more or less prominent (except in No. 4) over the top. All the species of this group, just like the European Grape-vine, have, on well-grown shoots, intermittent tendrils.

1. VITIS CORDIFOLIA, Michaux. Tall (or more rarely low), climbing high, trunks not rarely 6–9 inches in diameter. Leaves middle-sized or small ($2\frac{1}{2}$–3 or 4 inches in diameter), heart-shaped, mostly entire or very slightly tri-lobed on the edges, with broad shallow teeth, usually smooth and shining, more on the upper than on the lower side, the young ones sometimes, and very rarely the old ones, with short hair on the ribs below; berries among the smallest, in large, mostly loose bunches, black, without a bloom, maturing late in the fall, usually only with a single short and thick seed, marked by a prominent raphe.

This grows more especially in fertile soil, and is a common plant in river and creek bottoms. It is well known by the name of Winter Grape, Frost Grape or Chicken Grape. It is found from New England to Texas, and westward to the western limits of the wooded part of the Mississippi Valley. In this valley, at least, the fruit has a strong and even fetidly aromatic taste, which unfits it for making into preserves or for pressing wine. No cultivated varieties of this species are known.

2. VITIS RIPARIA, Michaux.—Mostly a smaller plant than the last, but with larger (3–5 inches in diameter) and more or less incisely 3-lobed, glabrous, shining (or rarely when young, slightly hairy) leaves, the lobes long and pointed, the teeth also more pointed than in *cordifolia;* berries usually larger than in the last, mostly with a bloom, in smaller and often more compact bunches, commonly 1 or 2-seeded; seeds with a less prominent raphe.

This species prefers thickets or rocky soil on river banks, and extends as far west and south as the last, and much farther north, being the only Grape-vine in Lower Canada, where it is found even 60 miles north of Quebec. The northern form, in Canada, northern New York to Michigan and Nebraska, has fewer and larger berries in a bunch, and is easily distinguished from *V. cordifolia.* The South-western form, however, a taller plant, with smaller black berries, approaches more closely to this last species, and often seems to run so close to it that in some editions of his manual, Prof. Gray has united both under the name of *V. cordifolia*, Mx. The fruit ripens earlier than that of *cordifolia,* and is much pleasanter. In St. Louis a variety found on the rocky river banks is brought to market in July. A number of cultivated varieties are referable to this species, among which the *Taylor Bullit*, the *Delaware* (which, however, is classed by many grape-growers with *æstivalis*) and the *Clinton*, are the most prominent.

3. VITIS ÆSTIVALIS, Michaux.—Smaller than the first, climbing over bushes and smaller trees; leaves large (4–5 or 6 inches wide), of firmer texture than the preceding ones, entire, or often more or less deeply and obtusely 3–5 lobed, with rounded sinus and with short and broad teeth; when young always very woolly or cottony, mostly bright red or rusty; at last smoothish but dull, and never shining like the preceding ones; berries usually larger than in both others, and, when well grown, in compact bunches, coated with a distinct bloom; seeds usually 2 or 3, with a very prominent raphe.

This is the well-known *Summer Grape* common throughout the Middle and Southern States, usually found on uplands and in dry open woods or thickets, maturing its fruit in September. It is the most variable of our grape-vines, and hence has seduced superficial observers into the establishment of numerous nominal species. A form with large leaves which retain their rusty down at full maturity has often been mistaken for *Labrusca*, which does not grow in the Mississippi Valley. Another form, more bushy than climbing, with deeply lobed rusty-downy leaves and sweet fruit, is *Vitis Lincecumii* of the sandy soils of Louisiana and Texas. *Vitis monticola* of Texas is a form with small entire leaves (the down of which at last is gathered in little tufts) and large acid berries. When this species gets into shady woods it assumes a peculiar form, approaching *V. cordifolia* through its smaller black berries, without bloom, with more acid taste, and in larger bunches. Another form with ashy-white, downy, scarcely lobed leaves, and fruit like the last mentioned, which grows in our bottoms, often climbing high trees, or growing over bushes on the banks of lakes, I have distinguished by the name of *cinerea*. It is not always easy to distinguish such forms from the other species, and perhaps less so to unite them under the single species, *æstivalis*, unless the essential characters above enumerated be closely attended to, and the numberless gradual transitions from one form into the other be watched.

We cultivate many varieties of this valuable species, the most important of which are the *Virginia Seedling*, the *Cynthiana* and the *Herbemont*.

4. VITIS RUPESTRIS, Scheele.—A small bushy plant, often without any tendrils, rarely somewhat climbing; leaves small (2–3 inches wide), mostly broader than long, heart-shaped or truncate at base, scarcely ever slightly lobed, with broad coarse teeth and usually an abruptly elongated point, glabrous, and of a glaucous or light green color; berries middle-sized, in very small bunches; seeds mostly 3–4, obtuse, with a very slender raphe.

This very peculiar grape-vine is found only west of the Mississippi, from the Missouri river to Texas and westward probably to New Mexico. In our State, where it is called *Sand Grape*, and in Arkansas, it grows on the gravelly banks and overflowed bars of mountain streams; in Texas also on rocky plains, whence the Latin name; it is there sometimes called *Sugar Grape*. Its luscious fruit ripens with us in August.

It is nowhere yet in cultivation, but may in future prove of value.

[The Grape-vine of the Old World, *Vitis vinifera*, Linnæus, finds its place in this section, between *Vitis riparia* and *Vitis æstivalis*. Though many of its cultivated varieties bear berries as large, or even larger than those of any of our American grape-vines, other cultivated forms, and especially the true wine-grapes, those from which the best wines are obtained, and also the wild or naturalized ones, have fruit not larger than that of the above named native species.

This plant, together with the Wheat, belongs to those ancient acquisitions of cultivation, the history of which reaches beyond the most ancient written records. Not only have the sepulchres of the mummies of ancient Egypt preserved us its fruit (large sized berries) and seed, but its seeds have even been discovered in the lacustrian habitations of northern Italy. It is a mooted question, where to look for the native country of this plant, and whether or not we owe the different varieties of the true *vinifera* to one or to several countries, and to one or to several original wild species, which, by cultivation through uncounted centuries, and by accidental and repeated hybridization, may have produced the numberless forms now known, which remind us so forcibly of the numerous forms of our Dog, which we also can not trace, but which

can scarcely be derived from a single (supposed) original wild species. Director Regel of St. Petersburg, ascribes them to the intermingling of a few species, well known in their wild state at this day; Prof. Braun, of Berlin, suggests that they are the offspring of distinct species yet found wild in many parts of Southern Europe and Asia, which thus he considers not the accidental offspring of the cultivated plants, as is generally believed, but the original parent stock. I may add, from my own investigations, that the Grape-vine which inhabits the native forests of the low banks of the Danube, "bottom-woods," as we would call them, from Vienna down into Hungary, well represents our *Vitis cordifolia* and *riparia*, with its stems 3, 6 and 9 inches thick, and climbing on the highest trees, its smooth and shining, scarcely lobed leaves and its small, black berries. On the other hand, the wild grape of the thickets of the hilly countries of Tuscany and Rome, with its lower growth, downy leaves, and larger and more palatable fruit, which "don't make a bad wine," as an Italian botanist expresses himself, (which was known to the ancients as *Labrusca*, a name improperly applied by science to the American species, and is called to this day *Brusca*,) reminds us, notwithstanding the small size of the leaves, of our *Vitis æstivalis*. The Grape-vines of the countries south of the Caucasus mountains, the ancient Colchis, the reputed original home of these plants, greatly resemble the Italian plant just described.

The European Grape-vine is characterized by smoothish, and, when young, shining, more or less deeply, five or even seven lobed leaves; lobes pointed and sharply toothed; seeds obtuse at the upper end, and mostly notched; raphe indistinct. In some varieties the leaves and branchlets are hairy and even downy when young; the seeds vary considerably in thickness and length, less so in the shape of the raphe.]

b. Berries large, 7, 9 or even 10 lines in diameter, raphe scarcely visible on the more or less deeply notched top of the seed; tendrils continuous.

5. Vitis Labrusca, Linnæus.—Plant usually not large, climbing over bushes or small trees, though occasionally reaching the tops of the highest trees, with large (4–6 inches wide) and thick, entire or sometimes deeply-lobed, very slightly dentate leaves, coated when young with a thick, rusty or sometimes whitish wool or down, which in the wild plants remains on the lower side, but almost disappears in the mature leaf of some cultivated varieties; berries large, in rather small or middle-sized, or, in some cultivated varieties, rather large bunches, bearing two or three or sometimes four seeds.

This plant, usually known as the *Fox-grape* or *Northern Fox-grape*, is a native of the eastern slope of the continent from New England to South Carolina, where it prefers wet thickets; it extends into the Alleghany mountains, and here and there even down their western declivity, but is a stranger to the Mississippi Valley. The most important varieties of this Grape-vine now cultivated in our country (such as the *Catawba*, *Concord*, *Isabella*, *Hartford Prolific*, and dozens of others) are the offspring of this species; a few produced by nurserymen, but most of them picked up in the woods; they are all easily recognized by the characters above given, and most readily by the peculiar arrangements of the tendrils as above described. Large and downy-leaved varieties of *V. æstivalis* are, in the West and South-west, not rarely mistaken for *Labrusca*, but the two may always be distinguished by the characters indicated.

II. Grape-vines with (on the younger branches), firmly adhering bark, which only in the older stems scales off; aerial roots from inclined trunks in damp localities: tendrils simple; berries very large (7–10 lines thick), very few in a bunch, easily detaching themselves at maturity: seeds with transverse wrinkles or shallow grooves on both sides:

6. Vitis vulpina, Linnæus.—Low, or often climbing very high, with small, (2 or at most 3 inches wide) rounded, heart-shaped, firm and glossy dark-green leaves, smooth, or rarely slightly hairy on the under side, with coarse and large, or broad and bluntish teeth.

This Southern species, known under the name of *Southern Fox-grape*, *Bullace* or *Bullet grape*, is found along water-courses, not further north than Maryland, Kentucky and Arkansas, though it may possibly straggle into south-east Missouri. Some of its

cultivated varieties, especially the white *Scuppernong*, are highly esteemed in the South, but do not produce fruit in the latitude of St. Louis.

I recognize only three other species of true Grape-vines in the territories of the United States. The most remarkable of these is the Mustang grape of Texas, *Vitis candicans*, Engelm. (*V. Mustangensis*, Buckley,) a tall climber, with rather large, rounded, almost toothless leaves, white, cottony on the under side, bearing large berries, which, like those of the wild *Labrusca*, show different colors, greenish, claret and bluish-black; and which, in its native country, are made into wine. In young shoots and sprouts the leaves are usually deeply and elegantly many lobed. *Vitis Californica*, Bentham, the only wild grape of California, has rounded, downy leaves, and small berries, and is not made use of as far as known. *Vitis Arizonica*, Engelm., similar to the last, but glabrous, with middle-sized berries, reported to be of a luscious taste. Neither of these show a prominent raphe on the seed, so that this character is peculiar to the first three species here enumerated.

(15) The instances that have come to my knowledge where varieties of *vinifera* have, in some measure, succeeded in this country when cultivated out-doors, are very few, except around New Orleans and in some other parts of Louisiana. Successful fruiting of this species is not uncommon there, and from all I can learn this exceptional fact bears directly on the question of Phylloxera, because *much of the land is of a sandy nature, and the water in most of it rises to within a foot or a few feet of the surface.* It is probable that success has attended the cultivation of this vine in such parts only of Louisiana as afford these conditions. Such conditions are unfavorable to the growth and increase of Phylloxera; and though it is generally supposed that the Grape-vine must have a dry soil and will not endure wet feet, I am assured by Dr. Jno. S. Copes, of the New Orleans Academy of Science, and by M. A. DuBois, wine merchant of the same town, that the vines in that locality must necessarily have wet feet. There is much other evidence to show that some varieties thrive with wet roots; and the following passages from an article detailing the experience of Mr. J. B. Garber, of Columbia, Lancaster county, Pennsylvania, and confirmed by our well-known Saml. Miller, of Bluffton,* are so full of meaning, unsuspected by their author, in connection with what we know of Phylloxera, that I can not refrain from quoting them:

> * * * You no doubt recollect that you and myself once being in Chester county (at Mr. Carnogo's, I think), we noticed a grape vine of such luxuriant appearance, and bearing so enormous a quantity of fine, perfectly healthy grapes, that we both were in doubt as to the variety until the owner said it was the Catawba—which we knew was a general failure in this section of country. Naturally we looked for the cause of this extra healthy vine; we soon noticed that it stood just below the pump, where all the waste water flowed over its roots, and that the wash-tubs were all emptied in the same direction, with all the slops and waste water from the house. The ground was continually soaked with water. * * * The only place where I have seen a Black Hamburg vine grown with any success in the open air, was in our neighboring county of York. There on a low trellis about a hundred feet long, stood a row of this variety on a low bank, two feet above the gutter where water was flowing nearly all the time: here the vines had at least wet toes, if not wet feet, the year round. The vines looked healthy, and were loaded with a fair crop of fruit when I saw them some ten years since. A near neighbor has his vines around the spring house, where the water is standing all about and over the roots, so much so that he has laid boards alongside of the trellises to walk on. He is celebrated for taking the largest and best Isabella grapes to market. His vines are free from rot or mildew, and hold their leaves until frost removes them. My own Concord vines, growing where the roots can reach water, are far more healthy, and produce more perfect and better grapes, than those standing on higher and dryer ground—on a good wheat and corn soil.

Is it not plain after the facts I have recorded, as to the susceptibility of European vines and of the Catawba to Phylloxera, and as to the efficacy of water, in sufficient

**Rural World*, March 14, 1874.

quantities, as a remedy, that those vines owed their exceptional life and vigor to freedom from Phylloxera as much as to excess of moisture, and perhaps to the former entirely?

According to Mölhausen, what is most probably the European vine, since it was first brought from Spain, flourishes around El Paso, New Mexico; but the system of culture is curious and exceptional. The vines are cut down to the ground each year, and in spring the vineyards are submerged until the soil is thoroughly soaked. In Prof. Planchon's words: "Is this not the very system of inundation of M. Faucon, applied by people, who, without knowing it, thus kill the Phylloxera on their vines."

Mr. D. T. Jewett, of St. Louis, has been measurably successful in the out-door growth of European vines. His success is so exceptional that it has been very generally considered and discussed for some years back at the meetings of the Mississippi Valley Grape-growers' Association. It is generally attributed to the effect of the intramural atmosphere, which rivals that of almost any city in the world in the amount of lime dust and bituminous coal smoke with which it is impregnated. But the following letter, which I print because it gives an authentic account of this interesting experience, indicates pretty clearly, that the exceptional success is owing more to the treatment of soil than to atmospheric influences, though these may have helped, together with the thorough enclosure and isolation of the vines from other vineyards, which doubtless for a time precluded the work of Phylloxera. I have italicised such portions of the letter as I wish to draw especial attention to:

Prof. C. V. Riley—*Dear Sir:*

In answer to your inquiries about what success I have had in the out-door culture of "foreign grapes," I will give you briefly the material facts.

In the spring of 1858 I purchased of a nurseryman a few varieties of grapes, and told him to give me one or more *white* grapes. I set out the white one on the south-east corner of my house (which is on the south side of the street). I dug for it a bed about three feet deep into the yellow clay soil, and five or six feet in diameter, and filled it with top soil, *thoroughly mixed with manure, sand and some bones*, and set out the vine in it. It grew very well, but died down during the winter. I laid it down the following winter, and covered it with straw, boards, etc., but still it died. About the third winter I laid it down and covered it four or five inches deep with earth, and it came out the next spring in perfect condition and bore grapes, and upon careful examination they proved to be the Golden Chasselas. I also got at the same time, and set out and treated in the same way, what proved to be the true European Rulander—not what is generally called here the Rulander or Ste. Genevieve, though it looks and bunches very much like it, but is a much better grape for the table. In the spring of 1861 I bought and set out the Black Hamburgh, the Black Prince, the "White Scotch Cluster" and the early "Malvasia," as the nurseryman called the last two. I set them out in the south end of my garden (my lot was 50 feet by 135), *which had been low ground, but which I had filled in with top soil and manure, sand and lime, in layers, and had had shoveled over and well mixed, so that there was a rich, mellow soil, about three feet deep, all over my garden.* These all grew well and bore a few grapes the third summer, and a good crop the fourth summer. I have taken as high as twenty pounds in a season, from each of a Black Hamburgh and a Golden Chasselas; but generally from five to ten pounds. I have had bunches that weighed about a pound, a little more or less.

About the middle of November of each year I trimmed them, laid them down and buried them three or four inches or more deep with dirt, and never lost one till the winter of 1871–2. I trained them generally on trellises, as you would the Concord, generally with two arms and uprights, letting them branch near the ground, so that they could be easily stretched upon the ground to cover up. In 1865 I bought a lot, of 25 feet front, on the east side of my other lots, had it dug over about two-and-a-half feet deep, heavily manured and slacked lime put on it, and planted with vegetables for two years, and dug over two or three times till the soil was thoroughly broken up and mixed; and in the spring of 1868, I set out in it about one hundred Chasselas and Rulanders, which I had propagated by cuttings from the first I had. These grew finely and bore some in 1870 and a good crop in 1871. In the fall of 1869 a house was built on the lot adjoining my garden on the east, and it took off a large portion of the sun, especially in the mornings. The fall of 1871 was very dry, and the following winter very cold, and in the spring of 1872 when my grapes were taken out of the ground, the wood looked as green and well as ever; but about one-half of my younger grapes and some of the older ones never put out buds, and gradually dried up. Others were very

feeble, producing small wood and scarcely any fruit, and many of them died the next winter, so that I have lost about all the hundred set out in 1868, and some of my older ones, and the other older ones have done poorly for two summers past. About the best I now have are the Chasselas, set out in 1858, and a Black Hamburgh set out about 1861 as a cutting. My Concord grapes, which I set in 1861, and which did finely till within two years, have also failed badly.

Within a few years many houses have been built near me, and though none but the one I have named keep any sun from my garden, still they have added much to the smoke and coal soot that settles around.

Whether it was the dry, cold winter of 1871–2, the want of sun to ripen the wood, the coal smoke and soot, one or all together that have done the mischief, I can not say. Whether your grape-louse has had a hand in it, I do not know, as I have made no examination.

The Chasselas has generally done the best of the foreign varities I have cultivated, but the Black Hamburgh, Black Prince, and Rulander have done well. They have not had any protection in summer except such as was given by my house on the north side, and a high, close board fence on the other sides of the garden. Those at a distance from the house do as well as those near it. The oldest Chasselas was in good bearing for ten or eleven years, and I believe would have continued many years longer, and all the others, but for the circumstances I have named.

I have satisfied myself that with intelligent care, the varieties I have named can be grown in this climate without the protection of glass, and give the cultivator an abundance of delicious table grapes out of his own garden, as I have had for many years. He must have a sunny garden, protected on the north and west at least, and a *deep, rich* soil. Two days' labor in the fall and two in the spring will lay down and take up a hundred vines and more.*

Yours, respectfully,
D. T. JEWETT.

Of numerous varieties of *vinifera*, mostly received from California, and planted on their own roots, by Mr. George H. Gill of Kirkwood, all have died except one which he obtained under the name of Malagar, and which still lives, though not in the most flourishing condition, and with the roots thickly covered with lice. Whether in bunch, berry or leaf, this vine looks very much like Rebecca, and as its history can not be traced by Mr. Gill with any satisfaction, it is more than likely that it is not *vinifera*. Both Dr. Engelmann and Prof. Planchon are at least of this mind, after making careful comparisons.

Mr. M. J. Labiaux, of Ridgeway, Warren Co., North Carolina, nothing daunted by previous failures, imported and planted last spring one hundred thousand cuttings from the south of France. There was not a Phylloxera on their roots last fall when Prof. Planchon visited him, and the young vines, notwithstanding an unusually dry season, had made a most luxuriant growth. The Phylloxera was, however, found in the neighborhood. I do not doubt that with proper care and culture Mr. Labiaux will yet be able to laugh at his incredulous and discouraging neighbors, *if he can only master the root-louse.*

(16) It were vain to attempt to anticipate results, and while some of the past grafting experience in this country is not of the most encouraging, there is nothing to indicate that good results may not follow thorough, full and systematic experiments; while much of said experience bears directly on the Phylloxera question. The Clinton has been very largely imported into France for stock purposes; but whether it will prove as valuable as Norton's, Cunningham or Herbemont, remains to be seen. Mr. Bush places little value on it as a stock, because of its great tendency to sucker and sprout and to supplant the graft. But precisely that which would prove best for us in this country might not prove best in France; and the very qualities for which Mr. Bush would condemn the Clinton are those which the French vine-growers need. They need,

*Since the above letter was written, and while these pages are going through the press, Mr. Lugger has, at my request, made an examination of these vines, as I had had no opportunity of doing so before. He reports them in very poor condition, and finds evidence of Phylloxera in the swollen and rotting roots.

first of all, a vine stock which is Phylloxera-proof. The Clinton comes as near being so as the other varieties mentioned, and its tendency to sprout will prove no obstacle to such careful cultivators as the French, if it only fulfills the other want; while its greater susceptibility to the leaf-galls will be of comparatively trifling moment if grown for its own fruit, (see *ante* p. 36), and, of course, no objection at all if used only as stock. The Rentz is very highly spoken of by Mr. E. A. Riehl of Alton, and by Mr. Bush, as one of our most promising N. A. varieties. I have yet had no opportunity of studying it in connection with Phylloxera, but as, according to Mr. Bush, it makes luxuriant roots, it doubtless enjoys the immunity belonging to a certain group of its species, Labrusca.

Just as these pages are going through the press, a fact comes to light through a communication by Prof. Planchon to the *Messager du Midi* (Apr. 21, 1874) which greatly strengthens the hope that the most satisfactory results will follow the introduction into France of our resisting vines. It appears that on a piece of land adjoining the town of Roquemaure, and in the very locality on the banks of the Rhône, forming one of the centers where, as has been clearly ascertained, the Phylloxera made its first appearance nine years ago, M. Borty, a wine merchant of the place, and owner of a fine vineyard, finding that his French vines were suffering from Oidium, and under the impression that American vines did not suffer from that fungus, imported 154 specimens of the latter about the year 1862. Most of these vines, after so long a trial, are not only living, but luxuriant and full of vigor; and indicate a resistance to the insect in singular contrast to the French vines in the same enclosure. Of these last most have been killed by the Phylloxera, while a few barely survive. Of the nature of the resisting American vines, Prof. Planchon, who, at the instance of the publisher of the journal above mentioned, personally visited them, in company with members of the Agricultural Society of Vaucluse, recognized with certainty the Clinton, and some of the others were received under the names of "Post-Oak," "Ives Seedling," "Clara," etc. But a most interesting feature of this experience, which has remained so long unknown and unpublished, is that the Delaware and the Isabella have both been uprooted because of the manner in which they suffered from Phylloxera.

This experience gives every assurance that our American vines which resist the disease at home will retain the same power when grown on the other side of the Atlantic.

Regarding the experience in grafting in this country, there are many published facts like that recorded of Mr. P. Manny of Freeport, Ills., who, finding that his Delaware, Iona and Salem vines lost their lower roots [doubtless by Phylloxera], remedied the matter by grafting on to Clinton (Rep. 4, p. 71, note); but I shall here record only such facts bearing on the subject as have come to my knowledge, and are yet unpublished.

In the herbarium of the Philadelphia Academy of Natural Science, Prof. Planchon and myself found a specimen, evidently of the European *vinifera*, and so labeled, with the following note, probably from the pen of Mr. Buckley, well known to botanists for his studies of our grape-vines: "No. 79, Black Sweet Grape; Introduced. Flourishes finely when engrafted on a Mustang Stock. I have known it when engrafted on a strong Mustang favorably situated, to produce ten bushels of grapes the fourth year. *Will not thrive on its own roots without a great deal of careful nursing.* Blooms in April; ripe in August."

Though proving nothing definite, the following result of grafting, made at my request by N. DeWyl of Jefferson City, will yet have some interest. The grafts were made in the spring of 1872:

Catawba on Clinton—Good growth; healthy, with no galls on leaves and few lice on roots. Catawba on Concord—Good healthy growth; more vigorous than on its own

roots; no leaf-lice, and few root-lice. Catawba on Norton's Virginia—Slow growth; no insects observed. Rulander on Catawba—Weak, slow growth; plenty of root-lice; died in the fall of 1873. Maxatawney on Catawba—Same as Rulander. Herbemont on Catawba—Total failure. Maxatawney on Clinton—Good growth and healthy; no galls on leaves and but few lice on roots. Goethe on Taylor—Good growth; no galls on leaves, but root-lice rather abundant.

The following experience communicated by Mr. Theod. Engelmann, of Looking-glass Vineyards, Mascoutah, Ills., is by no means encouraging. He writes:

The subject is not new to me and to my neighbors engaged, like me, in vine-culture, and I am sorry to say that our experience does not encourage the hope of success which you anticipate. We have been grafting vines more or less for many years, and as a general rule have selected as stock to graft new or tender varieties upon, the roots of the strongest and hardiest, but we have not followed any systematic or scientific course, and have not had the light before us which your observations of late years have shed upon the subject. I have Ionas on their own roots and also on Clinton; I never had a sound bunch of grapes from either. If there is any difference it is in favor of those on their own roots. I have Gœthe on their own roots, also on Clinton and on Concord, and I can see no difference in the growth and health of the vines and fruit. My next neighbor, Mr. Nestel, has grafted on a Delaware root a Concord vine, leaving also a vine or cane of the Delaware, so as to raise both Delaware and Concord grapes on the same stock; the Concord is perfectly healthy and ripens its fruit to perfection, while the Delaware shows all the symptoms of disease to which this vine is liable; yet Mr. Nestel thinks that these symptoms do not appear quite as early in the season and are not so marked as on the vines growing on their own roots, and concludes that the Concord is imparting some of its blood and health to its Siamese twin-brother. He has also a Delaware on Concord root, but can see no difference between it and those on their own roots. Mr. Hecker has experimented with European vines. He had them on Clinton, on Concord, and on the roots of the wild Summer grape (*æstivalis*); they were as much affected with disease and died within a few years, the same as those on their own roots.

Mr. Riehl, of Alton, Ills., who grafted onto Concord some Ionas, Ives, Maxatawney, Creveling, Walter, and several varieties of Rogers' Hybrids, some five years ago, is also of the opinion that the trouble can not be remedied by grafting.

Yet, again, in the vineyard of Mr. G. H. Gill, of Kirkwood, there are a number of *vinifera* vines, received from California, that have been grafted onto Concord roots since 1869; and these, though some of them have been declining for the past two years, are yet living; while the same kinds on their own roots, planted at the same time, are dead.

These statements are sufficient to show that experience is conflicting, and that while it would be unwise to draw conclusions now, there is much to hope for from future experiment. Indeed, so much depends on future experiments that I have sent the following circular-letter to a number of my grape-growing correspondents, and shall consider it a favor if any of the readers of this Report, who are interested, will next year comply, as far as they are able to, with its requests, and in time report to me results, or publish the same through the horticultural press of the country:

Dear Sir: You would do me a great favor if you would institute, as far as you conveniently can, the following experiments in grafting the vines indicated in the appended list. My own object in having these experiments made is to ascertain the effect of grafting the varieties which suffer most from Phylloxera, on to those which are the least susceptible to it. If you can make a portion, or but one or two, of the experiments indicated, I shall consider it a great favor to have you do so, and inform me precisely as to the number and varieties grafted, the character of your soil, and all other details of interest. I am instituting similar experiments myself, as are also some other of my correspondents, and my object is to have these experiments made on different soils, and in different latitudes. In the course of two or three years I hope to gather together the results from all quarters, and we may thus be enabled to draw conclusions of much importance to grape-growers. Feeling perfectly convinced that the injury to the roots caused by Phylloxera is the prime cause of failure of many of our more delicate and best grapes, I have every hope that by a proper system of grafting these onto the roots of those which suffer least from that insect, we may successfully grow several varieties which so far have proved delicate and unreliable.

Believing that the interest you take in grape-culture, and the satisfaction that will come of the consciousness of doing something to advance it, will repay you for what little trouble you may go to in instituting these experiments,

I am, yours very truly,

C. V. RILEY.

ROOTS TO USE AS STOCK.

1. Concord.
2. Clinton.
3. Herbemont.
4. Cunningham.
5. Norton's Virginia.
6. Rentz.
7. Cynthiana.

VARIETIES TO GRAFT ON TO ANY OR ALL OF THE ABOVE.

Of First Importance.

1. Catawba.
2. Iona.
3. Delaware.
4. Wilder.
5. Goethe.
6. Any European vine.

Of Secondary Importance..

7. Ives.
8. Hartford Prolific.
9. Maxatawney.

(17) I extract from the Transactions of the St. Louis Academy of Science (Vol. III, pp. 215, 216) the following descriptions of the mites mentioned:

TYROGLYPHUS PHYLLOXERÆ Riley & Planchon, Fig. 16.—When full grown 0.03 inch long, and about half as broad. Color pale yellowish, with a brownish medio-dorsal circular spot, around which there extends a gamboge-yellow discoloration, in some specimens restricted, in others occupying nearly the whole upper surface of the abdomen; trophi, legs, especially two anterior pair, and cephalothoracic sutures, of a faint rosy-brown; the epimera of a deeper brown. The hairs of the body arranged much as in *T. siro*, Linn., springing from minute papillæ, and not exceeding in length $\frac{1}{3}$ diameter of body. Tarsal or terminal joint of legs with a short and prominent basal hair (*d*); sometimes fine and knobbed at tip, sometimes more fleshy and rounded at tip (*f*); often lacking on the two hind pairs; also sometimes with other fleshy growths (*g*); tarsal claw usually distinct (*d*), but sometimes retracted or obsolete (*h*). The usual pair of small tubercles each side of vulva, and a larger flattened circular tubercle each side of anal slit in ♂.

When immature the color is whiter, with less of the yellow, dorsal discoloration, and the hairs are relatively longer. The form varies according as the cephalothorax is retracted or not, and the abdomen instead of being oval is sometimes constricted in the middle, at others more spherical.

Many of the characters enumerated belong to all the species of the genus; and in studying large numbers it is difficult to give any specific diagnosis which shall at once distinguish it from all other described species. To do so will require continued study of all the stages from the moment of hatching, as well as of its *Hypopus* form—a study which I have not yet been able to give.

HOPLOPHORA ARCTATA Riley, Fig. 17.—Length 0.028 inch; diameter scarcely half the length. The horny shield of a highly polished, smooth, mahogany-brown. Legs and trophi carneous-brown. Dorsum arched. Differs from most described Hoplophoras in the very smooth and unarmed covering, and from all in the great narrowness of body.

Found associated with the preceding, and probably feeding on the decaying roots. It is, I believe, the first American species described.

(18) A very conclusive proof of the perfect efficacy of inundation, and at the same time of the fact that Phylloxera is the sole and direct cause of disease, will be found in the Report recently made to the Minister of Agriculture and Commerce, of a visit to the vineyards of M. Faucon and neighborhood, by a commission appointed from the Department of Hérault. With the exception of M. Mares, who is cautious in recommending submersion lest the vines suffer, every other member (M. Vialla, M. de Saint Pierre and M. Gaston Bazille) considers the testimony conclusive that to inundation, and to it alone, is due the resuscitation of M. Faucon's vineyards, and highly recommends its adoption wherever feasible.

In 1870, M. Nicollas, of Crau, lost a large vineyard on the banks of the Marseille canal, through Phylloxera. In 1872, finding that another vineyard which he owned was attacked, he saved it by complete inundation with water from the Peyrolles canal—*Comptus Rendus de l. Ac des Sc.*, lxxviii, p. 697. Many similar instances might be cited of the perfect success of this remedy where properly applied, and proving that the success is owing solely to the drowning out of the insect, and not to any peculiar chemical properties in the water.

(19) M. Faucon discontinued the summer inundations last year because, first: he deems them not absolutely necessary; secondly: they cause a number of weeds to get the start which it is afterward difficult to repress; thirdly: because where the ground is not under-drained, the water, settling and heated by the summer's sun, injures the vines in the lower places and depressions.

(20) Late last fall I received a box of grape roots with an accompanying letter from Mr. G. L. Wratten, Secretary, on behalf of the Sonoma Wine-growers' Club. The letter described an insect which might be the Phylloxera, but the earth around the roots had dried to a powder, and I could find no possible trace of the insect after the most careful scrutiny. In answer to my request for further specimens, I received a letter under date of January 13, 1874, from which I extract the following, and thus the matter rests for the present:

> We are extremely sorry that the specimens sent did not arrive in good order. I took pains in the packing. Since the receipt of your last letter, myself and members of the Club have examined fully one thousand vines in different vineyards, where we had no difficulty in finding them before our winter rains set in, but now we can find none, and the only indication is a little of the yellowish mold from the old wood, and a few insects dead, swollen, filled with water, that the least touch bursts like a bubble. Before, we could pull off a little of the old outside bark and either remove the insects with a knife, or place them under a glass and see them full of life, but now the ground is full of water. We have now had about fifteen inches, and the prospect is that this will be a wet season. The vineyards, a week ago, could not be gone into at all, without sinking down six or eight inches. We expect before the season is over ten or twelve inches more of rain, and if we get it, we hope never to see or hear of these pests again. * * Many parties are pulling up every vine that shows any symptoms of having been attacked, intending to let the ground be vacant a year, treat it with lime and strong manure, and then plant with strong rooted vines.
>
> * * * * * * * * * * *

(21) Mr. A. S. Fuller, of Ridgewood, N. J., informs me that in Mr. C. W. Grant's celebrated vineyards at Iona, near Peekskill, N. Y., vines were frequently dug up on account of the nodosities, as far back as 1858; that the men were in the habit of combing out the roots of young vines to be sent off, with their fingers, to get rid of the knots; also that vines there suffered much in 1860.

Mr. W. N. Barnet, of New Haven, Connecticut, writing to the *Country Gentleman*, under date of April 28, 1873, says:

> There is one other question which I would like solved, viz.: a remedy for the insect that infests the *roots* of some nursery grown vines. Choice varieties that I have bought from large propagators have had this disease—*a bloated root*—and such vines

are sapped at the foundation and fail to grow. My only remedy has been to destroy the roots and re-root the tops, carefully setting them in another place, or to use the tops as grafts; but I do not like so severe a remedy.

Can you, Messrs. Editors, or S., or some "careful" correspondent, give me a milder one, equally effective?

N. N. C., a correspondent of the same journal (*ibid*, Aug. 28, 1873,) from Sewanee, Tenn., speaks of his Delawares being badly affected, and refers to both the gall- and the root-lice.

Around Philadelphia, as Mr. Meehan assures me, Catawba, Delaware, Iona, Israella, and most varieties except Clinton and Concord, have more or less failed.

Mr. H. W. Ravenel, of Aiken, S. C., has written me a long letter describing how most of the bunch grapes have there failed, although they succeeded admirably for awhile. L. Froelich testifies (Rep. Dep. Agr. 1871, p. 149,) that, in North Carolina, bunch grapes, after the first few years, show tendencies to disease. Mr. Berkmans gives a similar account for Georgia.

Mr. H. O. Fairchild, of Hammondsport, N. Y., writes that he finds Phylloxera on his Iona, Catawba and Isabella vines (other varieties not having been examined) which lately appear to be suffering.

On Kelley Island, Prof. Planchon found, on a large scale, the confirmation of what I have found elsewhere. The Delaware is in bad condition, while the Catawba, though sufficiently healthy here and there, is generally suffering; and Mr. Kelley states that it is failing more and more. In years past Mr. Kelley was in the habit of pruning the roots of his vines, by cutting off all the superficial roots, and he then noticed the nodosities. The habit which he had of piling these knotted rootlets in large heaps on the top of the ground, doubtless had the effect to kill many of the lice: at all events, since he has abandoned the practice the vines have been getting worse.

(22) The following recorded experience, taken during the past few months from but one of our agricultural journals—*Colman's Rural World*—and touching on the successful growth of native varieties which suffer more or less from Phylloxera, and generally fail, speaks volumes in connection with what we know of the influence of sand on the insect, and of other facts I have recorded.

Mr. T. Metzler, of Rhineland, Mo., in a recent number writes:

I will admit that the Catawba is not such a profitable producer as many other kinds. This grape needs different culture, location and soil from other grapes. I raise it on a place on the Missouri river where the soil is sandy and level. It is a place that heretofore would have been neglected by a great many vineyardists, but this is the place for the lovely Catawba.

Mr. E. Baxter, of Nauvoo, Ills., a well-known and experienced grape-grower, after considering the question whether or not grape-culture and wine-making is a failure in this country, says (*ibid*, Aug. 30, 1873):

I have now in my mind an experiment which has been carried on for the last six years by an intimate friend, with intelligence to direct and means to establish, and I will refer to him and his vineyards to demonstrate the truths I wish to impress on my readers. The first thing that attracts the attention of the stranger is the admirable selection of soil and situation of these vineyards, known as the White Elk vineyards, and situated some three miles north of Keokuk, on the bluffs which skirt the western shore of the Mississippi as far as Montrose, and facing the river, which they almost reach by a steep descent. The scenery of the country is very picturesque and presents a surface strongly rolling and naturally drained; this is no prairie with a level surface and a strong, black, rich vegetable humus, causing a rank vegetation. On the contrary, the soil is of a light colored clay loam, *with an admixture of sand from the sandy marls of the loess*, which forms that dry calcareous soil which a long experience has proven to be well adapted to the growth of grapes, as it also contains a sufficient quantity of the oxyds of iron, which ought never to be absent from those wines which have the pre-

tension to be medicinal. There are seventy-three acres in grapes, chiefly Concord, Catawba, Clinton, Ives, Nortons and Delawares. The work is done under different squads of men, every thing systematically and at the proper time; there is no slashing, breaking, or even pinching done during time of growth; the pruning is done soon after the crop is gathered; the plowing and cultivation is thorough, but of a light character; the soil is always loose and no weeds are suffered; and, in anticipation of mildew, *the vines are regularly sulphured by means of De Lavorgue's bellows.* No wonder that with this systematic care and treatment the vines are full of vigor and of fruit, notwithstanding the trying weather and other miseries which vines have had to encounter for the past few years. As a vineyard it is a success; a very limited loss of vines and a great production of fruit, the Concord for a red wine, and the Catawba for white wine predominating, they being without a doubt our preferred national wines.

"Uncle Davy," of Buck's Hill, Ky., whose experience Mr. Samuel Miller, of Bluffton, vouches for, and who refers the failure he mentions to rot, writes (*ibid* Nov. 2, 1873):

* * * I have visited nearly every vineyard worth seeing in southwest Missouri and northwest Arkansas; have been in correspondence with many of the owners, and have yet to see the first European hybrid or Fox Grape (Ives and Venango excepted) that would produce more than two good crops, or more than four that would pay for cultivation, etc. * * * The reports of the press are generally very good, but so was mine the first year, and so will be that of nearly every new beginner. The failures we do not like to report—and yet they are much more useful to study than success.

Mr. Miller himself writes (*ibid*, Feb. 28, 1874):

* * * I had near one hundred varieties in the East, among them, of course, Catawba and Isabella; yet I never raised a perfect bunch of the former on trellis, but did so when a vine ran upon a small apple tree. Isabellas are always a failure on my prepared land—lower drained and trenched two feet deep—but when a branch of a vine planted not far from a cherry tree took hold and was allowed to run on it, the fruit was always fine. Also a Garrigues, a variety of Isabella, fails on a trellis, but where it has taken on a Bowman's May cherry tree, it has large crops of splendid fruit.

One year when the grape crop was almost a universal failure, I visited a friend in York county, Pa., who had extensive vineyards, but no good fruit except a vine that ran on an ailanthus tree. Another season, when the grape crop in that section was nearly a failure, a friend sent me a basket of Catawbas, such as I had seldom seen or eaten, and so good and handsome, with the accompanying note: "These I gathered this morn ing from a Mazzard cherry tree, sixty feet from the ground."

Which is the most likely—that the tree benefited the vine, or that the greater length and depth of root, corresponding with the greater length of arm, enabled the vine to resist its hemipterous and subterranean enemy?

Of similar significance is the experience of a correspondent of the Department of Agriculture, who has had exceptional success with a vineyard, on the Potomac, some three miles above Washington, and who closes a communication in these words:

I am annually enlarging my vineyard, which now comprises about six acres; expect to enlarge it to ten next fall. The soil and sub-soil prove to be perfectly adapted to the growth of the grape, being composed of about equal parts of sand, loam and clay, and containing considerable quantities of mica, with a sub-soil of rotten rock, into which the grape roots penetrate several feet. It is also just porous enough to absorb the rains; consequently no draining is required.

The columns of our horticultural press abound in facts like the above, which, viewed from the Phylloxera stand-point, have a deep meaning; and I entirely agree with Mr. Husmann when, in recently demurring, in his own convincing way, from the idea that trees in themselves benefit a vine, he remarks, (*Rural World*, March 21, 1874): "To sum up our wants, I think we want longer fall pruning, early and judicious summer pruning, more room for our vines, and, last but not least, more thinking and observing vintners, who know what they are doing and why they do it."

(23) I have already shown (Rep. 5, pp. 68-9, note) how unreliable, as an observer, is M. L. Laliman, of Bordeaux, France, who is prominent among those who advocate

the existence of the Grape Phylloxera on fruit trees. A further illustration of how little can be depended on this gentleman's opinions, may be here mentioned: By request, he sent to Montpellier, as I am informed by different correspondents, the roots of a supposed cherry tree, covered, as he claimed, with Phylloxera. A single glance sufficed to show those more competent to judge in such matters, that the supposed cherry roots were in reality vine roots—the blunder being doubtless caused by the vine roots extending to and intermingling with those of an adjacent cherry tree.

(24) In answer to a writer, in the monthly report of the Department of Agriculture for January, 1874, who considers that the true cause of failure in the out-door culture of *vinifera* in this country is due to "fungoid growth," I have replied in these words (*N. Y. Weekly Tribune*, March 4, 1874):

"Had W. S. witnessed, as I have done over and over again in this part of the U. S., and as Prof. Planchon has done in France, the gradual decline and final death of varieties of *Vitis vinifera* with no *Oidium* or *Peronospora* on their leaves, but with their roots covered with Phylloxera, or depleted and wasted by the same, he would, I think, not speak so positively about the death of such vines being due to fungus growth. The proper use of sulphur is acknowledged to be a sovereign antidote for the fungus growths mentioned, and has so proved to be both in Europe and America; and were his statement really true, we should have no other hindrance to the successful out-door growth of *vinifera* in this country than a liberal use of that mineral. Unfortunately, such has not proved to be the case; and, however injurious these funguses may be, I am perfectly convinced that Phylloxera is much more injurious, and that it kills the vines mentioned, whether with or without the aid of parasitic plants."

It were needless here to repeat the reasons which I gave in 1871 for considering the Phylloxera more potent than any other one cause in destroying the European vine with us. They have been recently set forth in an admirable manner by Prof. Planchon in an elaborate article on the Phylloxera in Europe and America (*Revue des deux Mondes*, Feb. 1st and 15th, 1874), from which the following passage is so much to the point, and so fully expresses my own views, that I shall be doing my readers a favor in giving it a liberal translation:

"In presence of these repeated failures, the cause has very naturally been sought. Explanations in such cases are never wanting with the so-called practical man, who, as a rule, disdains scientific research, and readily contents himself with vague hypotheses, such as bad weather, difference of climate, and incapacity in the plant to become acclimated. If such causes act in exceptional cases, can they be applied to the European vine taken as a whole, i. e., to its innumerable varieties that flourish in Europe, Asia and Africa, under extreme climatic conditions, from Potsdam to the Canaries, and even into Egypt, in the Fayoum below 30° of latitude? Does not North America possess all varieties of climate, from Florida and Louisiana, where the Banana ripens, to Canada, where the rivers freeze annually; and is it not over the whole extent [of the eastern half] that the European vine has failed? Besides, if this failure is owing to extremes of climate, how explain the fact that the young plants prosper well at first, and gradually decline with age? Finally, if it is a question of climate, why is California studded with vast vineyards of European varieties, all flourishing, and cultivated ever since its first colonization by the Spanish? In truth, the European vine finds in North America, conditions of climate and soil which in the Old World would give it, comparatively, a very extended range. The same soils are found on both sides of the Atlantic: acclimation is a misnomer, if employed to mean anything else than that a plant is modified gradually, by possible selection in its descendants—modified, I say, to adapt

it to a new climate. Therefore, putting aside the above explanations, what remains to account for the fatality of our [the European] vines in the United States? A single thing, very small in appearance, very powerful in reality; hidden, and hence, for a long time ignored, but very manifest when once we have learned to see it, and follow, by careful study, its effects, first on the roots, then on the entire vine. This insignificant atom, which is legion, is none other than the Phylloxera. With this simple and palpable cause, first recognized by Riley, and which my recent studies in America have rendered to me most evident, all the facts may be connected and explained."

(25) PHYLLOXERA RILEYI Lichtenstein.—This insect, which, from specimens sent to him, Lichtenstein has kindly named after me, but of which I have not yet seen his description, may be characterized in comparison with *vastatrix*.

Apterous ♀—Length 0.016 inch, or rather more than a third as large as *vastatrix*, with which it agrees in color. Proportionally more slender, with the abdomen more tapering. Body insected and covered with tubercles very much as in wingless *radicicola* form of *vastatrix*, but with an additional pair on the head, and those on the seventh abdominal joint always distinct. These tubercles concolorous with the body, fleshy, more or less elongate—from 1-12–1-6 the width of middle body—and surmounted at tip with a short, dark hair. The anterior turbercles longest; the lateral outline showing a series of thirty-six such tubercles, nearly equidistant, springing at about right angles from surface. The intermediate dark points, on thoracic insections, also as in *vastatrix*. Antennæ precisely as in *vastatrix*. Legs with the ends of tibiæ more swollen, and the claws more prominent. Venter, with a dusky tubercle just inside each coxa. *Pupa*, (Fig. 18, *a*) with the tubercles prominent, and the pale mesothoracic portion occupying more of the body. *Winged insect*, (Fig. 18, *b*) with the dark mesothoracic band much as in *vastatrix*; the wings more slender and somewhat more fuliginous, with the costal angle more produced and blunt, and the hook larger on secondaries; the antennæ (Fig. 18, *c*) with the third joint and the horny parts proportionally longer. Also presenting two forms of body and wing as in *vastatrix*, the undoubted ♀'s also much the more numerous. Newly-hatched larva smooth, with dark limbs and eyes, the tubercles increasing with each molt, and sometimes noticeable before the first.

The species is less prolific, and the eggs proportionally larger, than in *vastatrix*, but in the tarsal characters of the young and more mature individuals, and in all other features not mentioned, there is perfect correspondence. The tubercles, as already indicated, are very variable in size. Numerous specimens examined.

(26) I have such faith in the unity of habit and unity of biological traits in the same genus, that I fully expect that future inquiry will show that the European Oak Phylloxera has a similar winter habit, and that the apterous and mouthless sexual individuals discovered by Balbiani, in the European species, exist in ours; and the same argument will apply to the Grape Phylloxera. What is clear, however, for the two species here treated of, is, that the solitary and fecundated egg, if it occurs, is not necessarily hibernal. The production of these sexed individuals may form a definite phase in the annual development of either species; but as the number of viviparous parthenogenetic generations, and the production of eggs in the true Aphides, are known to depend more on temperature and external conditions than on any definite biological inherency, I strongly suspect that the same will hold true of Phylloxera; and that the sexed individuals, while produced mostly in the fall, may also be produced at other seasons; further, that the young from the impregnated eggs will differ in nowise from those from the unimpregnated, except in their greater vigor and fertility.

One fact, which is not now interpretable, but may have a significance in future, I feel constrained to record in this connection. It is that, in examining *vastatrix*, I have occasionally met with degraded ♀'s ($_a$ form of *radicicola*) in which the abdomen, instead of containing numerous small ova, was well-nigh filled with a single much larger egg. Every observed fact leads to others yet unknown and unsuspected; and the full history of Phylloxera has yet to be written!

THE BLUE CATERPILLARS OF THE VINE.

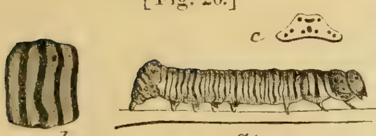
Having treated, disconnectedly, in my first three Reports of certain caterpillars, with zebra-like markings, which depredate on the Grape-vine, and which, from their bluish general appearance, are popularly designated "blue-caterpillars," it will be well to bring them together in one article, illustrating their distinguishing characteristics, and correcting all previous error or confusion. This is the more necessary, as our ability to counterwork their injuries depends somewhat on our being able to distinguish between them.

There are four distinct species of moths, whose larvæ, in form and marking, all bear a striking resemblance to each other; three of which, and perhaps all four, feed on the Vine. We have—

1. THE GRAPE-VINE EPIMENIS—*Psychomorpha epimenis*, Drury.

(Ord. LEPIDOPTERA; Fam. ZYGÆNIDÆ.)

[Fig. 20.]



PSYCHOMORPHA EPIMENIS:—*a*, larva; *b*, enlarged joint, side view; *c*, enlarged hump on joint 11.

[Fig. 21.]

PSYCHOMORPHA EPIMENIS:—Male moth.

This is a half-looper when young. It works mostly in the spring in the terminal buds, drawing the leaves together by a few weak silken threads. It always lives hidden within a sort of hollow ball made of leaves thus drawn together. It quits feeding by the end of May; bores into wood or other sufficiently soft substance at hand, neatly covering up its retreat; remains hidden as a chrysalis till the next spring, when it issues as a moth (Fig. 21), of a velvety-black color, conspicuously marked with white and brick-red. It is distinguished by having only four transverse black stripes to each joint, the intermediate space white (Fig. 20.) I have found it much more common than the others in St. Louis county. On the authority of Mr. Abbot, this species feeds also on the wild Trumpet Creeper (*Bignonio radicans*). For the entomological reader, I repeat, with little alteration, the description already published:

Psychomorpha epimenis, Drury—*Larva*.—General appearance bluish. The ground color is, however, pure white, and the apparent bluish cast is entirely owing to the ocular delusion produced by the white with the transverse black bands as in *Alypia octomaculata*. Transversely banded with four black stripes to each joint, the third and fourth being usually rather wider apart than the other two, and diverging at the lower sides, where they make room for two more or less conspicuous dark spots placed one below the other; the third on some of the middle joints is frequently broken, with an anterior curve, just above stigmata, and on joints 2 and 3 it is twice as thick as the rest. Cervical shield, hump on joint 11, anal plate, legs and venter, dull pale orange. Joint 1 with about 14 large shiny piliferous black spots, 8 of which form two rows on the cervical shield (those in the anterior row being largest and farthest apart,) and six of which are lateral, namely, three each side, with more or less distinct dusky marks between and in front of them. The spots on the hump are usually placed as at Figure 20, *c*, but vary very much, though the four principal ones on the top are generally placed in a square. The anal plate is marked with 8 such spots, very much as in the cervical shield, but smaller. The tips of the thoracic legs are black, and the other legs and venter are also spotted. Head gamboge-yellow, inclining to orange, with 8 principal and other minor black piliferous spots. The ordinary piliferous spots are small, and except two dorsal ones which are in the white space between the second and third bands, they are not easily detected. There are a few very minute pale lateral specks in the first and second pale bands. The hairs are pale and not generally longer than the spots from which they originate. The stigmata are also quite small and round. Venter pale, with dark mottlings and rows of spots on the leg joints. The abdominal prolegs decrease in size from the last to the first pair, and the larva curves the thoracic joints and is a half-looper, especially when young. Average length about one inch. Described from numerous specimens.

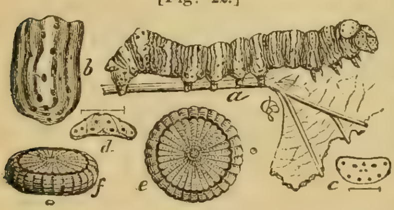
Chrysalis.—Average length 0.37 inch; reddish-brown; rugose, especially on dorsum of abdominal joints, but distinguished principally by the truncated apex, which has a large horizontally-compressed, ear-like, horny projection at each upper and outer edge.—3rd Rep. p. 64.

2. THE BEAUTIFUL WOOD NYMPH—*Eudryas grata*, Fabr.

(Ord. Lepidoptera; Fam. Zygænidæ.)

This worm (Fig. 22, *a*) may at once be distinguished from the foregoing by having six black stripes to each joint (*b*) instead of four, by the ground-color being slightly bluish, the middle of each joint being orange, and the black spots being more numerous. It feeds on the Virginia Creeper as well as on the Grape-vine, hiding on the underside of the leaves when at rest, but not drawing them together with web. On the authority of Mr. G. J. Bowles, of Quebec, Mr. William Saunders, of London, Ont., gives, also, as one of its food-plants, the Hop-vine.* It is most numerous in late summer and in fall

[Fig. 22.]



Eudryas grata:—*a*, full-grown larva; *b*, enlarged joint, side view; *c*, cervical shield from behind; *d*, anal hump from behind; *e*, *f*, top and side views of egg.

*First Ann. Rep. on the Noxious Ins. of Ont., p. 160.

when the Epimenis is never seen; and though it may be single-brooded in the more northern States, there are two broods with us, the moths from the first brood of worms frequently appearing twelve days after pupation. When at rest this worm depresses the head and raises the fore body, Sphinx-like, and, in order to transform, it also bores into wood and other like substances, though this habit seems not to be as inveterate in it as in the Epimenis, as Harris states that it burrows a few inches below the surface of the ground and there transforms without forming a cocoon.

[Fig. 23.]

EUDRYAS GRATA—Female Moth.

The moth (Fig. 23) has the front wings milk-white, broadly bordered and marked with rust-brown and olive-green; the hind wings nankeen-yellow, broadly marked, more or less, with pale brown on the hind border. It is seldom seen with us till May, and is most common in July and August.

The eggs of this insect (Fig. 22 *e*, *f*, the adjacent outlines showing natural size) are of curious shape and beautiful structure, and are laid singly or in little groups. They are flattened like the fruit of the common Mallow (*Malva*), and beautifully sculptured with radiating ribs and delicate transverse lines, the color being faint greenish-yellow, with a crenate black circle near the border. My figures are drawn mostly from memory and from notes made while with my friend, Mr. Saunders, who obtained them from the moth in July, 1870. This species is less common with us than the preceding, and seems to flourish best in more northern latitudes.

EUDRYAS GRATA—*Egg.*—Flattened, the periphery quite circular: diameter 0.035 inch; thickness not more than ¼ the diameter. A central cell bordered with dusky, and surrounded with a ring of smaller cells, from which radiate about 30 series of cells, more perfect near the center, and only forming parallel crescents toward the border, which is well defined by a crenate black rim; the sides bulging out more or less beyond this rim. Color translucent-yellow.

Larva.—Average length 1.50 inch. The ground-color more or less bluish; in last stage and full grown specimens, quite bluish. Six black, irregular, transverse stripes to each joint, and about 18 piliferous spots, 6 supra- and 6 each side, sub-stigmatal—all except that just behind stigmata and another above prolegs, more or less connected with the two middle dark stripes; several additional black specks; the two middle stripes farthest apart and the space between them orange. Head yellow with 9 black piliferous spots to each cheek (6 around ocelli and three above), the upper one accompanied behind by one or two black specks; also 6 such spots in pairs around epistomal suture, the upper and lower pairs more or less confluent; there are also 2 spots on labium; 2 on mentum; 2 on the cardinal piece of maxillæ, and several on the legs. On the cervical shield they are arranged as at *c*, and on the posterior hump as at *d*. Black

stripes varying much in thickness, and the spots in size and conspicuity. The orange frequently quite deep, inclining to fulvous. The hairs from some of the spots quite obsolete, and not generally longer than the width of the orange bands. When young the color is pale yellowish-green, with no black bands and no spots on the head. These subsequently appear, and are, with the venter, at first vinous-brown, and only in the last stage are they pure black. It spins a web, especially when young.

Described from many specimens found feeding on *Ampelopsis*, and from others found feeding on *Vitis* by Mr. Wm. Saunders and Mr. J. R. Muhleman.

The description in Packard's *Guide* (p. 282) must, I think, have been made from some other larva, as there is nothing approaching "fascicles of hairs" in *grata*.

Chrysalis.—Dark brown, finely granulated. "Fifth to seventh rings of abdomen separated by deep sutures, while the surface of each ring is flat, not convex, with two rows of small teeth; lower down on the sides of the body are four tubercles, being the remnants of the two middle pairs of prop legs. The remaining rings are less angulated. The tip of the abdomen is obtusely conical, ending in four tubercles, the pair above long and truncate, those below broad and short. On the under side are two minute approximate tubercles."—Packard.

3. THE PEARL WOOD NYMPH—*Eudryas unio*, Hübner.

(Ord. Lepidoptera; Fam. Zygænidæ.)

[Fig. 24.]

Eudryas unio:—Male moth.

As was long ago remarked by Dr. Fitch, this worm so closely resembles that of the Beautiful Wood Nymph "that we know not yet whether there are any distinguishing characters between them." Such is actually the case; and it is difficult if not impossible to determine the species in the larva state. Dr. LeBaron* has attempted to do so; but it is very evident that he has mistaken for this larva that of *Psychomorpha epimenis*, which I once thought there was reason to believe was *unio* I have not seen living specimens, but upon comparing with *grata* two alcoholic specimens kindly loaned for the purpose by Mr. J. A. Lintner, of Albany, N.Y., who found them feeding on *Epilobium coloratum*, I can discover nothing which will enable us with certainty to distinguish the two species, unless it is the smaller size, the lesser prominence of the hump, and greater paleness medio-ventrally, in *unio*. Mr. Lintner informs me that he thinks he could distinguish this last by the heavier markings in black (broader bands and larger spots) and especially by a blackish shade over the prolegs. But none of these characters, unless it be the lesser size of the hump, are sufficiently constant to be of any distinguishing value; for as, in *grata*, they vary in different individuals and according to age, they will doubtless be found to vary in a similar manner in *unio;* and I have

* *Prairie Farmer*, June 3, 1871, and Aug. 2, 1873.

specimens of *grata* with the black markings and the shade over the prolegs, caused by the greater heaviness of these markings in that region, fully as heavy as in the two specimens of *unio* examined.

The grape-feeding habit of this larva rests solely on the authority of Dr. Fitch, who probably reared it from this plant. But unless he did so, it is possible that it never touches the Grape-vine, though so closely allied to *grata*. If the Doctor did not so completely shut himself out from the entomological world, such questions as these might be at once settled; but my own experience is that one might as well try to turn stones into bread as to get a written word from the former State entomologist of New York. The *Epilobium coloratum* on which Mr. Lintner found it feeding is the only species of its genus that grows with us. The larvæ reared by Mr. Lintner buried themselves in the sand, in which were stuck their food-plant; but it is not improbable that this was an exceptional mode of pupating, consequent upon the circumstances, just as *grata* has pupated with me without any covering, or in silk-fastened leaves, when it could get nothing soft to eat into.

The moth (Fig. 24), with us is about as common as the Beautiful Wood Nymph, from which it differs principally in its somewhat smaller size, the paler color of brown markings; the inner edge of the brown border of front wings being wavy instead of straight, and the border of hind wings extending to the costa, instead of fading off about half way to it. On the under side, also, the marginal bands reappear, whereas in *grata* they are seldom more than indicated near the apex of front wings. Typical specimens of the two species are readily distinguished from each other; but with sufficient material, the distinguishing characters, whether as regards size, color or pattern, are found to be inconstant; and the two species really approach each other through connecting individuals, in such a manner as not only to speak most eloquently of a common origin, but to betoken recent differentiation, and to render it doubtful whether they have yet become sufficiently separated to be ranked as good species, according to the criterion of inability to cross and produce fertile offspring. The only other species (?) of the genus is one recently described as *brevipennis* by Mr. Stretch* from a headless and otherwise imperfect specimen found in California. It is distinguished principally by its broader and shorter wings, but otherwise combines the characters of the two better known species, the discal spot on the upper surface of the secondaries which Mr. Stretch seems to think peculiar to it, occurring in *grata* as it is found in Missouri, and sometimes being quite appa-

* Illustr. of the Zygænidæ and Bombycidæ of N. A. by Rich. H. Stretch, I, 151.

rent in *unio*. I have little faith in species based on such slight differences and scanty material, where its congeners are known to differ so much; and am a little surprised that a species should so be made by one who has shown that he fully appreciates the variation that species are subject to, and who has even ventured much farther in sinking species than I have thought proper to, by merging *Callimorpa fulvicosta* Clem., with *C. Lecontei* Boisd. *

Mr. John Kirkpatrick of Cleveland, Ohio,† has reared the moth from larvæ and chrysalides found in dead stems of the Swamp Rose-mallow (*Hibiscus militaris*), and gives a description of the larva from specimens which had already buried themselves, and which is, consequently, quite misleading, as most larvæ change much in appearance after concealment prior to pupating. He gives no proof that they fed on the mallows, and as he expressly states that there were thousands of grape-vines within easy reach, it is probable that the worms, after quitting the vines, sought the *Hibiscus* stems, simply for purposes of transformation, in accordance with their peculiar boring habit at this time.

In the moth state, both species of Eudryas rest during the day on the under-side of the leaves, with the wings closed roof-fashion over the back, and the heavily tufted front legs stretched forward. In this position they bear a close resemblance to a bit of bird-dung.

EUDRYAS UNIO—*Larva.*—Since the above was written, Mr. Lintner has favored me with advance sheets of an article "On the Larva of *Eudryas unio* Hübn. and allied Forms,"‡ from which I quote the following detailed description of the larva:

Head rounded, its diameter somewhat exceeding one-half that of the body, orange with black spots, of which there is an oblong one near the base of the clypeus, two semi-ellipsoidal ones surmounting its apex and a small quadrangular one on each side; a perpendicular row of five spots on each side of the clypeus, of which the second superior one is the largest, a spot above the ocelli, and a row of three behind them. *Body* tapering regularly toward the head, from the eleventh segment, which is elevated in a hump. First segment white, with two transverse bands of black spots, and with two black bands only seen when extended. The abdominal segments have each three white and three black bands on each side of a central orange band. The orange band is the broadest; it is marked dorsally on its anterior margin by two transversely elongated black spots resting on the black line margining it, and laterally by two geminate similar ones, of which the upper is the larger and the lower embraces the stigma; behind the lower margin of the stigmatic spot, centrally on the band, is a small rounded black tubercle bearing a short hair; on the posterior margin of the band, resting on the bordering black line, are two subdorsal semi-elliptical black spots, forming with the two anterior spots a "trapezoid;" between these subdorsal spots are two or four black points, of which the two interior sometimes assume the form of a "dove-tail" medial process of the black band; the orange band extends downward to the black bases of the prolegs, midway between which and the stigmata, on or in range with the third black band, is an elongated hair-bearing black spot, and posteriorly another similar one, lower and running into the black bordering the prolegs. The white band preceding the orange is interrupted or greatly contracted on the medial line by an enlargement of the black band anterior to it, and is marked with a small piliferous black dot in front of the stigma. On the second and third segments the orange band is marked with a row of eight spots, of which the six superior are located in the middle

* Illustr. of the Zygænidæ and Bombycidæ of N. A., I, p. 237.

† *Ohio Farmer*, Feb. 8, 1868.

‡ Entomological Contributions, No. III, in 26th Rep., N. Y. St. Cab. Nat Hist., pp 117-24.

of the band, and the two inferior coalesce with the black band margining it behind. On the eleventh segment the trapezoidal fuscous spots are of a well-defined oval form; above the stigma is another similar spot. On the twelfth segment the corresponding spots are round, and the trapezoid has its broadest side in front. The anal shield bears two spots centrally and five marginal ones, of which the medial one is elongated. On the sides of the larva a yellowish shade rests on the incisures. Ventrally, white and black interrupted bandings are observable on the abdominal segments when extended; the thoracic region is almost wholly white; on segments four and five the orange band is continued beneath, inclosing on the former four and on the latter six rounded black spots. The legs are dull yellow, tipped or edged on the two joints with black, and dotted with black interiorly. The prolegs are dull yellow, with a velvety black base, and with two lateral lines and three black spots (one small); the terminal pair have a black line outwardly and a cluster of black spots behind, which, as well as all of the black spots noticed in the above description, are piliferous, having the hair somewhat longer and stouter than in *grata*.

Length of the mature larva one inch and one-eighth; diameter three-sixteenths of an inch.

Mr. Lintner then quotes me as writing to him that I find the "two species absolutely undistinguishable," (my friend has here done me injustice by omitting the qualifications, for what I did write was essentially what I have said above, making reference to the smaller hump and smaller size), and then makes out the following list of differences:

Contracted by their preservation in alcohol, the two *unio* larvæ average in length 1.05 in.; the six *grata* 1.29 in. They differ in form, in that the latter presents much the more prominent hump on the penultimate segment, and is angulated at that point to a degree that were it a vertebrate, it would suggest the idea of its terminal portion dragging from having been broken at that point; in *unio* the hump is moderate, and the peculiar angulated form, well represented in the figure, is not seen.

Unio is the more heavily marked with black, both in its bands and spots. In none of the examples of *grata* are the black bands broader than one-half the width of the intervening white ones, while in one *unio* their average width is nearly double that of the white. The spots on the head are the same in position in both species, but are smaller in *grata*. In that species there are usually two distinct piliferous spots on the base of the clypeus; in two of my examples these are confluent, running together by slender projections in a broad V-form; in *unio* the two are united as a band across the clypeus. In *unio* a black spot, broadly rounded beneath, following the curved line of the ocelli, and tapering to a point above, incloses the four superior ocelli; this is not present in *grata*, but in two examples some of the ocelli are indistinctly annulated with black.

At *c*, in Fig. 5, [see 22], the spots on the collar of *grata* are faithfully represented in position, but their size might have been slightly enlarged. In *unio*, the four spots of the anterior row are separate, but those of the posterior row, from their greater size as compared with *grata*, are confluent, except the two medial ones; in *grata*, these spots are separated by spaces varying from one diameter of a spot to two and one-half diameters.

The spots on the caudal hump of *grata*, shown at *d*, in the figure, are isolated, while in *unio* those in each row are connected by the black band to which they are united.

Similar comparisons might be instituted of all the other spots of the two species, but the above may indicate their differences. The feature which should serve better than any other to distinguish *unio*, is the blackish coloring (its outline not permitting its designation as a stripe), above the prolegs and continued on the two following segments, the three piliferous spots above the prolegs being connected with it; this is entirely wanting in *grata*. It results, apparently, from the increasing breadth and coalescence of the black bands as they descend to the ventral region. In one of the examples, the ventral region of the proleg segments is essentially blackish, which feature was also observed in a number of the living larvæ, according to my recollection and that of Mr. Meske, who also collected the larvæ and bred from them several imagines.

The differential features above indicated are not entitled to the reliability that would attach to them, were they drawn from living examples; but should they prove to be sustained by future observations, there need be no necessity of failing in the determination of these species, when either may chance to be collected.

After all these minutiæ, I find no reason to change the opinion I have expressed above, and unless the relative smallness of the anal hump (and the difference in this respect is not so very striking) prove a constant and reliable criterion, he would be rash who would decide whether a single larva brought to him, without knowledge of its age

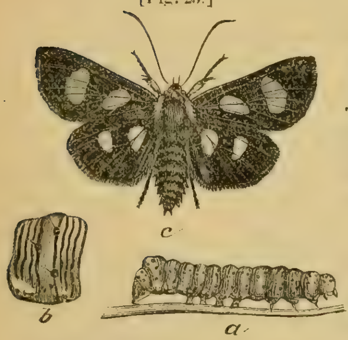
or food-plant, were *grata* or *unio*—and "distinguishable" to me means the ability so to do. I have long since learned to value a short and comprehensive description, which covers the characters of many specimens, above one which deals too much in variable details of fewer specimens. As already stated, the spots and stripes are so variable in *grata* that individuals placed alongside of the two *unio* larvæ, loaned me, were absolutely undistinguishable in these respects, and answer, in every point, to Mr. Lintner's description of *unio*. Size, while specifically a good criterion in full grown specimens, even where the difference is no greater than in these two species, is of little value in distinguishing individuals, as I have a captured *unio* imago larger than some *gratas*. Length of hairs from the black spots is likewise of no value whatever, as the relative length is the same in the two species. Indeed the length of these hairs alone would not distinguish *Eudryas* from *Alypia*, for while those of the latter are longer in the young larva, they are as described further on, when it is full grown. There consequently remain no constant differences between the larvæ of *grata* and *unio*, except the smaller anal hump, the lateral yellowish shade which "rests on the incisures," as described by Mr. Lintner, but which I did not notice in the alcoholic specimens, and the greater paleness medio-ventrally in the latter.

Unless, therefore, the living *unio* larva presents characteristics not noticeable in the alcoholic specimens, I would not undertake to specifically determine an individual with any confidence, however easily and confidently the two may be distinguished when full grown and in large numbers on their respective plants.

4. THE EIGHT-SPOTTED FORESTER—*Alypia octomaculata*, Fabr.

(Ord. LEPIDOPTERA ; Fam. ZYGÆNIDÆ.)

[Fig. 25.]



ALYPIA OCTOMACULATA:—*a*, larva; *b*, enlarged joint, side view; *c*, female moth.

This worm (Fig. 25, *a*) though resembling the two preceding in being marked with orange bands across the middle of the joints, may be at once distinguished by having *eight* (Fig. 25, *b*,) instead of six black stripes to the joint, and by having a series of lateral white sub-stigmatic spots.

ALYPIA OCTOMACULATA—*Larva*.—Average length, when full grown, 1.30 inch. Of same form as *Eudryas*. Ground color white, marked transversely with 8 black stripes to each point, and a broader orange band, bounded by the two middle stripes, which are generally interrupted ; orange band faint on joints 2 and 3, or sometimes quite obsolete ; conspicuous on 4 and 11 ; uniform on intermediate joints. In the middle joints each orange band contains eight black conical, elevated spots, arranged in two rows, each spot giving rise to a white hair, seldom longer than the width of the band. These spots are arranged as in the enlarged section shown in the engraving (Fig. 25, *b*,) namely, four on each side, as follows : the upper one on the anterior border of the orange band, the second on its posterior border, the third just above the spiracle on its anterior border—each of the three interrupting one of the transverse black lines—and the fourth, which is smaller, just behind the spiracle. The anterior dorsal spots on joints 4, 5 and 6, and the posterior ones on 11, considerably larger than the rest. Head and cervical shield, shiny, deep orange, with black piliferous spots. Venter black, slightly variegated with bluish-white, and with

the orange band extending across the legless joints. Legs black, false legs with two black spots on an orange ground, at their outer base. A lateral white wavy band, obsolete on the thoracic joints, and most conspicuous on 10 and 11, running just below the spiracles, and interrupted by the transverse orange band, and sometimes obsolete in front of it.

Five specimens examined, taken on *Vitis*. Harris (*Correspondence*, p. 286) enumerates only 6 black stripes between the orange bands, as he did not count the two bordering the same. When young this worm is whitish with brown transverse lines, the colors not contrasting so strongly as in the more mature individuals, though the black spots are relatively more conspicuous and the hairs springing from them longer.

In habit this worm is much like the Beautiful Wood Nymph, and like it there are two broods each year, and Maj. J. R. Muhleman of Woodburn, Ills., informs me that in 1870 he obtained a third.

This larva transforms to chrysalis within a very slight cocoon formed without silk, upon or just below the surface of the earth, and issues soon after as a very beautiful moth of a deep blue-black color, with orange shanks, yellow shoulder pieces, each of the front wings with two large, light yellow spots, and each of the hind wings with two white ones. The illustration (Fig. 55, *c*) represents the female, and the male differs from her in having the wing spots larger, and in having a conspicuous white mark along the top of his narrower abdomen.

This insect is more common with us than in the New England States. I have found it on the Concord, Taylor and Wild *riparia*, but on no other genus of plants. It is sometimes extremely abundant; and Mr. T. A. Gates, of Massilon, Iowa, suffered much, last fall, from the depredations of a worm determined as this species by Dr. Le Baron.

SUMMARY.

We thus have at least three, and probably four distinct grape-vine worms which, while they belong to three distinct genera, are yet of the same family, and so closely resemble each other in general appearance that none but the practiced entomologist would be likely to distinguish between them. No. 1 (*Psychomorpha epimenis*) is the smallest species, has no orange bands in the middle of the body, and but *four* black transverse stripes, to each joint, on a white ground. It is our commonest speciest, is single-brooded, and found only in spring. No. 2 (*Eudryas grata*), and No. 3 (*E. unio*) are not easily distinguishable except in the average larger size and comparatively larger hump of the former; but are easily separated from the others by having *six* transverse black stripes to the joint, on a bluish-white ground. They are seldom abundant in Missouri, being more at home farther north, and are most abundant in late summer and fall, as there is

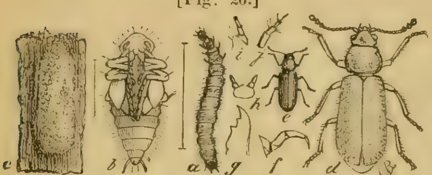
more than one annual brood. No. 4 (*Alypia octomaculata*) has eight black stripes to each joint, and a series of white patches to each side. It is sometimes quite abundant and injurious, and most so in the fall, being double-brooded. Nos. 1, 2, and probably 3, all have an inveterate habit of boring into wood, and other like substances, to pupate. Hence, broken corn-cobs, or pieces of wood, scattered around the base of the vines, may be used as traps to allure them. For No. 1, such traps need be collected and burned but once a year. For Nos. 2 and 3 they should be collected during summer, soon after the worms disappear. Cleanliness in the vineyard will greatly assist in preventing their injuries. With No. 4, which is not known to have this boring habit, the ordinary modes of destruction in the case of leaf-feeding larvæ can alone be relied on.

Mr. Saunders has reared what he takes to be the Red-tailed Tachina-fly (2nd Rep., Fig. 17) from No. 2. Beyond this, no parasites are known to prey upon them, though I have found lady-bird larvæ devouring No. 1.

THE RED-LEGGED HAM-BEETLE—*Corynetes rufipes* (Fabr).

(Ord. Coleoptera; Fam. Cleridæ).

[Fig. 26.]



Corynetes rufipes:—*a*, larva; *b*, pupa; *c*, cocoon; *d*, beetle, enlarged; *e*, same, natural size; *f*, leg; *g*, *h*, *i*, *j*, mouth parts of larva, enlarged.

I thus popularly designate a beetle which, from the great injury it causes to cured hams, has well earned the title. Its larva, from the paper-like cocoon which it forms, is known to the trade by the name of "paper-worm," and there is a very strong impression among those who know more of curing hams than of natural history, that the worm is generated by the rotting of the paper in which the ham is wrapped, and that it is consequently, in a great measure, due to an inferior quality of paper.

The insect has acquired more than ordinary importance during the past year, from the fact that it was the cause of an interesting suit for damages which was arbitrated before the Chamber of Commerce of Cincinnati, in favor of the defendants. Samuel Davis, Jr., & Co., of that city, sold a large lot of hams to S. S. Pierce & Co., of Boston, and the latter, finding most of them injured by the "paper-worm," made reclamation on the sellers for damages. The defendants objected on the ground that the hams had been injured while in possession of the purchasers.

I append the following statement of facts as communicated to me by the Messrs. S. S. Pierce & Co., through their attorney, W. L. Pierce:

C. V. Riley, Esq., St. Louis, Mo.—*Dear Sir:*

Twenty tcs. of hams, which we received from Messrs. S. Davis, Jr., & Co., during the months of April and May, 1873, were well cared for, in the best manner possible, by being taken from the cask and hung up in our loft, which for fifteen years past has been used for the same purpose. We had no occasion to use any of the hams until the following August, when they were found to be full of worms. We at once made claim on the packers, but could get no satisfaction whatever. Several modes of settling the question were proposed, and at last it was agreed to leave it to referees. Before making our statement, we had the hams examined by two of our most eminent packers, who gave their opinion in writing; and also Messrs. Goulard, Smith & Co., the regular ham examiners appointed by the Boston Board of Trade. Mr. Baldwin, one of the above gentlemen, stated that whereas Messrs. S. Davis, Jr., & Co. had previously used manilla paper in bagging their hams, they now use husk paper, which is very likely to contain the germ from which the worm is bred. You will probably know how far the statement is correct. The arbitration committee which decided the question was composed of ham-packers, all doing business in Cincinnati, and they probably found it impossible to decide a question against a fellow-tradesman, especially as such decision might at some future time be used against themselves. At all events, the question was not fully considered, for, instead of deciding a simple case upon its merits, they made it very complex by discussing points which had no particular bearing on this case, as the following extract from their decision will show:

"It being in evidence that the hams were in good condition when shipped from Cincinnati, and in apparent good condition on arrival in Boston in May and June; the delay of examination of the hams until August, and the well-known fact to the trade that a warm, damp atmosphere and want of free circulation of air on the hams will produce or generate the worm in light-salted S. C. hams; the question whether the worms are generated from the seed deposited during the process of curing or not is a question of doubt to the trade, and has not been settled to the satisfaction of parties at variance."

Please to remember that it had been particularly stated that the hams were hung in a cool, dry atmosphere, where there was free circulation of air; also that the hams were hanging in the same place awaiting the decision of the arbitration, and outwardly to all appearance in as perfect condition as when they left Cincinnati. We should like to ask you privately what is the use of bagging and painting hams unless to protect the meat from being fly-blown; also, if the fly can penetrate the outside wrappers of painted canvas and paper.

Having pledged ourselves to abide by the decision of the arbitration, we were bound to hold our peace, although, in our judgment, had the merits of the case been fully discussed, and evidence been taken touching every point of the same, and prejudice of location been avoided, a different result would have been obtained. * *

It is surprising that the parties in dispute in such a case seldom think of seeking competent scientific as well as legal advice. A lit-

tle entomological knowledge would have thrown a flood of light on the subject, and, from all I can gather through correspondence, would have entirely changed the verdict: for the idea of conditions of atmosphere, or of the meat generating the worms, is simply absurd. Judging from descriptions, the "paper-worm" figured most in the injury referred to, and as its natural history, as here detailed, will show, if the Boston firm could prove that the hams had been well cared for, and the covering kept intact while in its possession, there was but one legitimate conclusion, viz.: that the ova were deposited, and the injury, therefore, done in germ, before the meat left Cincinnati. Of course, in such a case, the parties run the risk of getting poor entomological advice, as they do of getting poor legal advice, for there are quacks in all professions; but it is no more difficult to discriminate in the one case than in the other, and even a poor entomologist would be apt to throw more light on such a subject than the best of lawyers.

A somewhat similar and very interesting case, where scientific knowledge was called into play, lately came before a jury at Norristown, Pennsylvania. The question was as to whether the trunk of a tree can elongate after it has once formed? Botanical science (and the experience of surveyors and others who have good opportunity of judging confirms its truth) says emphatically, no, because the cell once formed does not elongate or change, and such elongation is impossible, however much the external morphological features of tree-growth may make it appear to take place on a superficial view. Yet, in this case, the jury decided, from the evidence brought forward, that a peg in a certain buttonwood tree had been raised 4 inches in 48 years, and condemned botanical science as wrong. But science does not say that the trunk of a tree may not be raised. On the contrary, a pretty thorough discussion of the matter, brought out by the above case, and much of it in the columns of the *N. Y. Tribune,* elicited the fact that there are at least three ways in which such a peg may be elevated; but they are all mechanical, and not by the elongation of the trunk: 1st. There is such power in cell-growth that the enlargement of the roots on a rock surface acts with such force against the rock as to gradually lift the tree. 2d. Frost exercises a lifting power on the largest trees, on the same principle that it draws clover and other plants out of the ground, and brings stones to the surface, viz.: by expanding and thus lifting the soil, and vegetation with it: in thawing, the water carries earth under the lifted roots, which prevents their sinking fully to their former place: such action is naturally most apparent on trees in exposed places, and not anchored by deep tap-roots. 3d. If a peg is driven into a tree at an acute instead of a right

angle, the annual growth around it will gradually approach nearer to the top of the peg, which, thus getting shorter, also has its base at the juncture with the tree proportionally elevated. Now the botanist who would have decided that such a peg could not be elevated, would have been simply unscientific, and as wide of the mark as was the jury in condemning botanical science. Science is the correct interpretation of Nature's truths, and the false reading of them is spurious science, and should never be dignified with more than the name of theory, which—excellent in its place—must not be confounded with demonstrable fact.

In the year 1871, and previously, Francis Whittaker & Sons, St. Louis, of sugar-cured ham celebrity, suffered serious loss in the injury done by this insect. Being summoned, in 1871, to visit their large establishment to investigate the habits of the worm which caused them so much trouble, I was soon able to propose a remedy which has proved effectual and satisfactory. About the middle of May the parent beetle (Fig. 26, *e*) first makes its appearance. It is of a steel-blue color, with the legs and base of antennæ red-brown, and, to the naked eye, it appears smooth and metallic, though, in reality, evenly punctate and slightly pubescent, (*d*). It may be found about almost any dead animal matter in field or wood; but a city life seems to possess decided attractions in its complex and beautifully faceted eyes. In the establishment of Messrs. Whittaker & Sons, wherever the female can find an exposed piece of ham, there she takes good care to consign a number of her eggs. These eggs are 0.04 inch long, five times as long as wide, and slightly narrower at one end than the other. In a very few days there hatch from these eggs minute white larvæ, with brown heads, a black spot on the first and last joints, and two small hooks or tubercles at the tip of the body. These grow apace, burrowing in the fatty matter next the rind, and especially congregating in the hollow of the bone at the butt end of the ham. With age, this larva becomes darker, and when full-grown, (Fig. 26, *a*), is grayish-white, with a series of brown patches superiorly.

When about to transform, this larva gnaws its way into the more fibrous parts of the meat, or into more solid substances, as wood, etc., and makes for itself a white cocoon (Fig. 26, *c*), of a glistening paper-like substance, not spun from a spinneret as with most insects, but disgorged or spit out in little globules from the mouth. Each globule retains its form in drying, so that the outside of the cocoon usually appears granulated, though the inside is rendered smooth by the continual movements of the animal.

The pupa (Fig. 26, *b*), which has two large tapering fleshy processes at the tip of the body, is at first whitish, but the abdomen soon be-

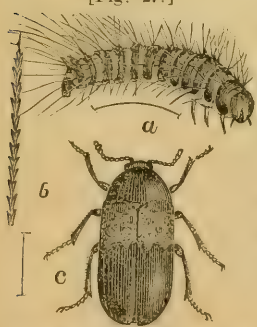
comes deep bluish, in strong contrast with the wing-sheaths and fore part of body, which remain white.

This insect attacks more particularly such hams as have been injured by over-heating in the curing room or by exposure to sun and rain. It is also attracted by the fatty secretion or slime which appears on the outside of such hams as have been left too long to lie in a pile; but it never seems to deposit eggs, or the young hatching from them fail to reach the meat, except where the covering is cracked or worn away, and the ham left in a measure exposed.

The sugar-cured hams are first wrapped in brown paper, then sewed up in canvas, and finally dipped in a mixture of flour, water, a little glue and chrome-yellow, and sometimes barytes or "heavy spar." They are then hung up by the butt end. The coating is sufficient to protect them from depredators, if thoroughly applied, and if it entirely fills up all the interstices of the canvas. I found that the principal injury was done at the small end, around the prominent bone of the shank, where the canvas, receiving most pressure, is most apt to give way. I also found that none of the beetles issued before the first of May, and ordinarily not till the middle of that month. I therefore suggested to the Messrs. Whittaker to use a stronger and heavier canvas, and to get all the canvasing and covering done earlier than was their custom, or before the first of May. They last year used a canvas one-third stouter than that formerly used, and also carried out the other recommendations. The result was, they did not lose a single ham or have one returned by customers.

The injury done to the meat by this insect is more apparent than real; for while it gives the outside of the ham a disagreeable look and makes it unmerchantable, the inner meat, not touched by it, remains sweet and unaffected. In its injurious work it is aided by the American Carrion-beetle (sometimes called the Bacon-beetle) *Silpha Americana* (Linn.); the Larder-beetle (*Dermestes lardarius*, Linn., Fig. 27; *a*, larva; *b*, one of its barbed hairs greatly magnified; *c*, beetle), and certain blow-flies. None of these, however, are so apt to do injury to fresh hams, but seek, rather, those which are tainted and injured.

[Fig. 27.]



DERMESTES LARDARIUS: *a*, larva; *b*, one of its barbed hairs; *c*, beetle.

There are doubtless several broods of this insect each year, as the larvæ grow quite rapidly and the beetle is found in the fall of the year. It hibernates solely in the larva state.

All the species of the family to which this Ham-beetle belongs are carnivorous, as larvæ, either feeding on lignivorous insect-larvæ or on

dead animal matter. The larva of *Clerus apiarius* (Linn.) is found in hives feeding on the young of the common Honey-bee. The larva of *Corynetes violaceus*, a species common to Europe and America, has been found in the powder borings of deal wood in England, but as Mr. Westwood* suggests, it was doubtless preying on the true wood-borer (*Anobium*), just as I have found the larva of a large and beautiful click-beetle, *Hemirhipus fascicularis*, Fabr.) in the heart of pecan and hickory trees, but always in such as were infested with the Hickory Borer (*Clytus* [*Cyllene*] *pictus*, Drury), whose burrows it follows, and whose larva it probably preys on.

The genus *Necrobia*, (meaning life in death), which differs so little from *Corynetes* that it is not therefrom separated by the best authors, is noted, from one of its species (*ruficollis* Latr.) having been instrumental in saving the life of the celebrated French entomologist Latreille. As he himself has written: "In the days which begat revolutionary fanaticism and the unbridled ambition of some men, I found this insect at Bordeaux, on the walls of the prison in which I was detained. Enclosed in a small roll of linen, sealed up, and sent to Bory de St. Vincent, this insect became the means of my deliverance." Latreille was at that time a priest at Brives-la-Gaillarde, and, with others who had not taken the oath, was thrown into prison at Bordeaux and condemned to transportation to Guiana for life. One day, finding this new *Necrobia*, as above stated, he examined it with such interest and delight that the prison surgeon who was present asked, "Is it a rare insect"? "Yes," replied Latreille. "In that case," said the surgeon, "you should give it to me: I have a friend who has a fine collection of insects, and who would be interested in the rare specimen." This friend was Bory de St. Vincent, who, becoming interested in Latreille, managed to obtain his release from prison just as the vessel he was to have left in (and which foundered off Cordova, with only the sailors saved) was about to sail; and finally succeeded in having Latreille's name scratched off the list of exiles.

CORYNETES RUFIPES—Larva (Fig 26, *a*)—Body 12-jointed; largest in middle, narrowing slightly both ways; faintly wrinkled transversely, (one wrinkle, between the joints, most prominent laterally), and with two longitudinal lateral folds; sparsely covered with pale ferruginous stiff hairs; color grayish-white with a series of brown patches each side superiorly; venter paler; joint 1 with a rounded, brown, horny shield covering it superiorly, and joint 12 with a more flattened plate terminating in two black, recurved, dull-pointed projections; stigmata circular, very inconspicuous, but normally arranged, viz.: 1 each side between joints 1 and 2, and in the middle of joints 4–11. Legs (Fig. 26, *f*) rather short, slightly pilose, the tarsus formed of a single claw; the fleshy anus is prominent, and is used as a sort of pseudopod. *Head* dark brown, longer than broad, and slightly narrowest in front; flattened; superiorly very

* Intr. etc. 1, p. 267.

slightly shagrened, with a medial, anteriorly, diverging, dark suture, having a paler one diverging each side from its base, the whole reminding one of a Greek Ψ (psi); inferiorly smoother, with a darker hind border, and with two almost parallel medial sutures; mouth directed upward; antennæ (Fig. 26, *j*) long, recurved, 3-jointed; joint 1 nearly as long as 2 and 3 together; 2 with a few bristles around the truncate end, which gives out a small nipple; 3 only ⅓ diameter of 2, ending in a long, stiff bristle and a few verticillate smaller ones; labrum subquadrate and pale; mandibles (Fig. 26, *g*) slightly falcate at tip, broadening to base, the terminal half strongly tridentate; maxillæ with inner lobe not prominent, and furnished with but few bristles; maxillary palpi (Fig. 26, *i*) 3-jointed, naked, joint 3 longest; labium (Fig. 26, *h*) small, the palpi naked, 2-jointed, the terminal joint longest.

The newly hatched larva is white, with the head dark-brown and the horny plates on joints 1 and 12 black.

Described from many specimens. If Chapuis and Caudèze' description of the antennæ of *Cleridæ* larvæ, as consisting of "two shortened joints," is correct, then our *Corynetes* larva materially differs from the other members of the family in this respect.

Pupa (Fig. 26, *b*)—with the anus terminating in two rounded tubercles inferiorly, and two larger, tapering fleshy points superiorly. Sparsely garnished with stiff, rufous hairs.

THE CLOVER-HAY WORM—*Asopia costalis* (Fabr).

(Ord. LEPIDOPTERA; Fam. PYRALIDÆ).

This is a very widely distributed little insect, for it occurs in many parts of Europe and Canada, and is quite generally found throughout the Eastern and Middle States, and in the Mississippi Valley—having, no doubt, been originally imported into this country from Europe, like so many other troublesome species which infest dried grains, fruits and other preserved food. Such insects are easily and almost unavoidably transported from country to country, and as there were, so far as we have any knowledge, no clover stacks made in this country before Columbus' time, we have an *a priori* reason for not considering the present species indigenous. It must either have been imported or—if native—have acquired an entirely new habit during recent times. So far as we have any positive knowledge,

[Fig. 28.]

ASOPIA COSTALIS:—1, 2, larva; 3, cocoon; 4, chrysalis; 5, 6, moth with wings expanded and closed; 7, worm, covered with silken web.

it feeds on no other plant,* and certainly not on clover in its green and growing condition, for I have, in vain, endeavored to feed it with such. Nor is a worm that is so fastidious as to touch none other but clover hay, likely to prove a general feeder.

ITS PAST HISTORY.

For many years grievous complaints were made in this country of a worm which infested clover, both in the stack and mow, and spoiled it for feeding purposes by interweaving and covering it with abundant white silken web and black excrement, much resembling coarse gun-powder. Frequently the silken matting is so dense that the hay looks moldy, and it is not improbable that much of the "clotting" and "burning" clover, so often referred to in our agricultural journals, may be, in reality, the work of this worm. Harris† refers to certain "clover-worms, which have been found in clover, in various parts of the country, and have often been seen spinning down from lofts and mows where clover has been stowed away;" and quotes Mr. Stephen Sibley as having observed these clover-worms "suspended in such numbers by their threads from a newly gathered clover mow, and from the timbers of the building, as to be very troublesome and offensive to persons passing through the barn," and as stating that "these insects were of a brown color, and about half an inch long." These extracts evidently refer to the worm under consideration, as do also the following, which will convey an excellent idea of its mode of working:

CLOVER WORMS.—We are sorry to see by a letter from T. C. Randolph, Bucks Post Office, Columbiana county, Ohio, that this new pest of farmers, reported last year by an Indiana correspondent, is moving eastward. Mr. Randolph found "about eight inches of the bottom of a clover stack so full of these clover-worms as to render the hay unfit for use. They are half an inch long, of a dark brown color, tapering each way, ridged, and hatched from cocoons [they hatched from eggs, and spin the cocoons] resembling those of the

*Mr. Townend Glover, of Washington, D. C., has, it is true, figured the larva in one of his unpublished plates of Lepidoptera (LXXIII, Fig. 25) on a head of green and blooming clover; but this is simply a blunder, and is certainly not based on any ascertained fact.

Mrs. Mary Treat, of Vineland, N. J., communicated to me the fact, some years ago, that she had bred this insect from oak leaves, the worms congregating in a nest made by drawing the leaves together. I am strongly inclined to think that she has mistaken for *costalis* the very closely allied *olinalis*. This last I have myself bred from a larva found on oak leaves, but at once distinguished from that of *costalis* by its greater size and by having a mottled head, and a broad subdorsal stripe darker than dorsum and edged both above and below with a narrower black line. It is so much like the larva of *Tortrix paludana* Robinson (which binds together the leaves of Oak with glistening white web interspersed with black excrement) that I mistook it for that species, which I had previously bred. I have, consequently, no detailed description of the *olinalis* larva. [Upon inquiring of Mrs. Treat, since this note was written, she informs me that she was wrong in referring her oak-bred species to *costalis*, but that—having saved no specimens—she is unable to determine the real species.]

† Ins. Inj. to Veg., p. 456.

bee-moth. Their excrement also resembles that of the moth, and is mixed all through the hay. With the thermometer at freezing-point they are lively, and were moving when the thermometer was at 6° below zero."

A sample of living specimens of the worms arrived in good order. We think it is a pest wholly unknown to Eastern farmers.—*N. Y. Sem. Week. Tribune*, Feb. 16, 1866.

CLOVER WORM IN THE STATE OF NEW YORK.—M. C. Remington, Auburn, N. Y., writes. Feb. 28:—"I read your account of the clover-worm at the West, and dreaded its advent in the East. I little thought that, even then, this pest with its myraid host was stealthily doing its work of destruction on my own premises. Having occasion during last week to remove a stack of clover hay, I found the bottom of it, for two feet from the ground, full of brown worms about five-eighths of an inch long, tapering both ways, ridged, with the extremities a little darker than the center. The hay in spots was white with their cocoons, having the appearance of a white mold, which I took it to be, until on unloading the hay I found the wagon alive with these active agents of destruction. Can anything be devised to prevent their depredations? Would thoroughly salting be likely to prove beneficial? The subject, I think, is worthy of serious consideration." *N. Y. Sem. Week. Tribune*, March —, 1866.

WHAT ARE THEY?—During the past summer I cleared out a bay which had not been entirely emptied in some ten or twelve years, and so much refuse had accumulated as to injure the hay. As soon as I had cleared off a little of the top, a sight presented itself to me that fairly made me shudder—there were thousands, if not millions, of brownish or greenish-black worms, about three-quarters of an inch long, squirming and crawling in every direction; the chaff was alive with them—the most disgusting looking mess I ever saw; but after awhile it was finished and drawn away into a pasture. The bay was half of a 26 by 36 barn, the other half being filled with hay. I have just finished drawing home this mow of hay, and find that these worms have destroyed a load of clover at the bottom, and penetrated up through three feet of timothy, apparently without injuring it, to a couple of loads of clover, and spoiled it; it was cut to chaff, and looked as if it was mow burnt, and was filled with their droppings, which looked like onion seed. * * * What are they, where did they come from, and will they go away of themselves, or what shall I do to kill them?—D. S. B., Fort Ann, N. Y., in *Country Gentleman*, Feb. 16, 1871.

In the *Practical Entomologist* for June, 1866, Mr. Walsh recorded what had, up to that time, been published of these worms; but nothing was known of their natural history until the spring of the next year, when an account of the insect's transformations was given by myself.* Around Alton, Ills., and in St. Louis county, many cases of injury by this Clover-hay Worm have come to my knowledge within the past four years, and in 1870 it attracted a good deal of attention around Eureka.

*Prairie Farmer, Apr. 20, 1867.

ITS NATURAL HISTORY.

During the summer months the moth frequently flies into our dwellings. In 1868, during the months of May, June and July, it was one of the most abundant species attracted to the light of my room in St. Louis, from the fact, doubtless, that there were infested clover stacks in the neighborhood. These moths, with the wings of a lilaceous purple, marked, as in the illustration, with golden-yellow (Fig. 28, *5*, *6*), may frequently be seen, on a cloudy day, or in the evening, flitting around where clover is being stacked or stored. The eggs must be fastened to such clover as the females can find access to by creeping into the crevices and fissures which a stack affords. The worms, of different shades of olive-brown (Fig. 28, *1*, *2*), flourish on their dry food, and generally dwell within a delicate cylinder of silk (*7*). There are, doubtless, two or more broods during the year, and they may be found in mid-winter of all sizes, retaining activity with the thermometer below freezing point. The cocoon is formed either near the outside of or entirely away from the stack, or mow, and generally under some piece of board or other sheltering substance..

It is a little curious that while the moth has long been known in Europe, and is figured and described in several popular English works under the trite vernacular name of "Gold-fringe," its larva is yet unknown there; and certainly nothing is on record there of its attacking clover in the manner in which it does with us. H. Noel Humphrey, in "The Genera of British Moths," (p. 124), refers to it under the generic name of *Hypsopigia*, and quotes its larva as "said to feed on Poplars," a say-so, not likely to be founded on fact. Mr. Robt. McLachlan, the well-known English neuropterist, on the contrary, told me while at his house, that the moth, though by no means common in England, had been seen flying around hay-stacks, and had, he thought, been bred from dry raspberry canes.

REMEDIES.

From what we now know of the habits of this insect, (and there is much yet, in detail, to learn), the only way to defeat its attacks is by adopting certain preventive measures: First, as the worms feed solely on dry clover, it follows that during summer they must be confined to such unfed hay as remains over from the previous year's making. Therefore, new hay should never be stacked in contact with old. The occurrence of the worms in such prodigious and destructive numbers, as indicated in the above-quoted paragraphs, must appear somewhat exceptional, when we consider how wide-spread the insect is;

and these exceptional cases may be accounted for by supposing the hay to have been stored on the same sites, or in the same situation, for successive years. In confinement, the worms show a tendency to work their way to the bottom of whatever they are confined in, and we may conclude that this tendency is natural. It will account for their being found so generally at the bottom of a stack. Yet, aside from this tendency, it follows that wherever clover is stacked for successive years on the same foundation, the bottom, coming in contact as it does with the infested leavings of the previous year, will necessarily suffer most. Secondly, as the worms show a preference for the moister and more compact portions of a stack, it will be well to build on a good log or rail foundation. This gives an air passage underneath, and is, besides, a commendable practice. Thirdly, I should recommend salting the hay, especially the two or three feet near the bottom; for while it is a good practice as a preventive of moldiness, it may also prove an antidote to the worm nuisance. Mr. Rich. Wray, of English Prairie, Ills., who has suffered much from this insect, and who believes that the infested clover is injurious, and may even prove fatal, to stock, informed me, many years ago, that he had used both lime and salt, with poor results, but that his trials were not thorough. I have little doubt, from some experiments I made, which showed that the worms would not eat well-salted clover, that thorough salting will preserve a stack from their attacks.

ASOPIA COSTALIS (Fabr.)—*Larva.*—Length 0.70–0.75 inch; diameter 0.08 inch; general color dull dark-brown with an olivaceous hue. Thoracic joints much wrinkled, the rest each with two wrinkles, the anterior one usually one-third wider and lighter colored than the other. Each side of dorsum on each wrinkle is a small round polished space, lighter than the body, with a dark central shiny spot giving rise to a very fine dull-white hair. Along the stigmatal region, on the anterior or lighter wrinkle, is another almost square, light space, somewhat swollen and as wide as the wrinkle, and having two shiny spots, one, smaller below the other. At the extreme outer edge the body is generally lighter, with a dark longitudinal, irregular, impressed line, above which anteriorly, and below it posteriorly, is a small point also giving rise to a hair. Venter lighter than dorsum, with a row of dots and hairs on each side. Legs concolorous with venter, the abdominals with a spot and hair exteriorly.

When young they are much lighter than when mature, and the head, cervical shield and caudal plate do not become dark till after the last molt. Some specimens, even when mature, are much lighter than others, the two wrinkles often being of the same color, though the insections are always dark. The light spaces are not so conspicuous in the dark specimens. Anterior and posterior usually darker than the middle joints. Very lively, wriggling backward as well as forward.

Cocoon.—0.50 inch long, oblong-oval, of pure white silk, mixed with excrement and particles of clover.

Chrysalis.—0.33–0.36 inch in length. Color honey-yellow, with segments and members clearly defined by the insections being of a deeper color.

Imago.—Average alar expanse 0.83 inch. Color lilaceous or purplish, with a silky gloss. Front wings with a slight grayish hue, and with two large, bright, golden-yellow costal spots, dividing their anterior portion into three equal parts; the outer spot largest, with a lilac-colored line, rather lighter than the ground-color, continuing from its posterior margin in an almost straight transverse line toward the posterior angle; the inner spot smaller, with a similar line extending from it, but obliquing more toward the base. Hind wings lighter than front wings, except near the posterior margin; with two wavy light straw-colored transverse lines, the outer one starting a little outside the middle of the wing on the costa, where it broadens, and curving to the anal angle. All the wings margined with deep orange, which is broadest at apex of primaries. Fringes having the appearance of raw spun silk, being of a very glossy, golden-yellow, deepening a little toward base, and separated from the orange wing-margin by a more or less distinct, very narrow, pale yellow line. Under surface with the colors more luteous, and the markings less distinct, the hind wings having apparently three transverse lines, when held between the light, the posterior one being nearer the hind margin of the wing than it is superiorly. Legs and head of a glossy straw-color. Body the same underneath, lilaceous at sides, and darker, more grayish, above. Thorax like the body; the prothorax and tegulæ being lighter. Palpi and antennæ pale orange, more or less distinctly tinged with lilaceous. Certain individuals much paler than others.

There is considerable variation in the relative distinctness of the transverse lines and size of costal spots, as well as in the depth of ground-color.

We have another species, the *Asopia olinalis* Gn. (see p. 103, note), which has probably been confounded with it, and which Zeller erroneously supposes has been so confounded in the *American Entomologist*.* *Olinalis* has a larger average size (expanding one inch); is deeper colored, with head and feelers more purplish; has the transverse lines usually less distinct, though with a deeper coincident shade basally; but is especially distinguished by having the basal third (sometimes half, sometimes three-fourths) of fringes of a purple (rather brighter than the general tint) color, and the margin of wings narrowly lined with black scales instead of broadly lined with orange. Consequently, the wings appear much more narrowly rimmed with gold. The underside is also more uniform and darker than in *costalis*, and the posterior transverse line on the secondaries furnishes one of the best distinguishing features, for it is more clearly defined, and runs almost directly under the similar line on the upper surface, and, therefore, much nearer the middle of the wing, than in *costalis*.

THE LEGGED MAPLE BORER—*Ægeria acerni* (Clemens).

(Ord. Lepidoptera; Fam. Ægeriidæ.)

Vieing with the Flat-headed Borer, in destructiveness, but generally following in its trail and rendering more conspicuous the damage which that species does to our shade maples, the insect under consid-

*Beitr. z. Kenntn. d. nordam. Nachtfalter: Part 1, pp. 53-4.

[Fig. 29.]

ÆGERIA ACERNI:—*a*, *a*, larva, dorsal and lateral views; *b*, *b*, *b*, cocoons exposed by detachment of bark; *c*, moth; *d*, chrysalis skin as it is often left remaining in the hole of exit.

eration deserves notice. It may be called the Legged Maple Borer, because the possession of sixteen legs at once distinguishes it from the Flat-headed Borer. It is, indeed, in structure similar to, and belongs to the same family as, the common Peach-tree Borer (Rep. 1, Fig. 17), and the more common Currant-stem Borer (*Æ. tipuliformis*, Linn).

The worm (Fig. 29, *a*) burrows under the bark of our soft maples, feeding on the inner bark and sap-wood and never penetrating deeply into the more solid heart-wood. It is so numerous at times that it completely girdles, and thus kills outright, trees of considerable size; while smaller trees are weakened, and rendered liable to be broken by wind, even where the worms are less numerous.

The burrowings of the worm are filled with its dark brown pellets of excrement, and cause the bark to crack open and loosen. The cocoon (Fig. 29, *b*) is loosely formed of white silk, and covered with the same brown excrement, and when about to give forth the moth, the chrysalis works its way partly out of the bark (Fig. 29, *d*) through a passage which, as larva, it had providently prepared, having left but the thin epidermis, which the chrysalis easily pushes through. The moth (Fig. 29, *c*) is a very pretty species, particularly distinguished by the large anal tuft of bright orage-red hairs. It was first described in 1860, by Dr. B. Clemens, under the name of *Trochilium acerni*,*

* Proc. Ac. Nat. Sc. Phil.; 1860, p. 14.

This insect is catalogued in Grote and Robinson's "List of the Lepidoptera of N. A.," by the name of *Ægeria acerni* Walker; and as the natural inference is that Walker was the original describer, the reader may as well be reminded that the "List" referred to is gotten up on the plan of attaching as authority the author who places a species in the last-accepted genus, and not the first describer of the species—a plan which I deprecated in my 4th Report (p. 55, note). I am glad that Mr. Crotch in his recent "List of the Coleoptera of N. A.," has thrown his influence against this unjust and misleading custom. Authors do not seem to have come to any satisfactory unanimity as to what are the distinguishing features between *Ægeria* Fabr. and *Trochilium* Scopoli; and how slight and trivial the differences are, may be judged by the following diagnoses, given by Harris in 1839 (*Silliman's Am. Journ. of Sc.*, XXXVI., p. 288).

TROCHILIUM.—Wings narrow, entire, all of them, or the hind pair at least, transparent. Antennæ short, stout, arcuated, gradually thickened nearly to the end, which is curved but not hooked; underside generally fringed with a double row of very short bristles in the males. Tongue very short. Body thick; abdomen slightly tufted at the end.

ÆGERIA.—Wings narrow, entire, all of them, or the hind pair at least, transparent. Antennæ mostly elongated, sometimes short, arcuated, gradually thickened nearly to the end, which is curved but not hooked; underside generally fringed with a double row of short bristles in the males. Tongue long. Body slender; abdomen nearly or quite cylindrical, ending with a flat or trilobed tuft.

The present species would come under *Ægeria*, according to these definitions, but Clemens regarded the *Ægeria*, as employed by Harris, as synonymous with *Trochilium*, and so placed the insect

and redescribed by Mr. P. Gennadius in the *American Naturalist* for January, 1874 (p. 57).

Many years ago I bred this insect from maples that were being injured by it around Chicago, and made brief reference to it in the *Prairie Farmer* for April 17, 1869. In 1867, while on a visit to Mr. B. N. McKinstry, of East Sumner, Ills., I found that he had lost many young trees by it. It has also been unusually abundant around Onarga, Ills., and infests more or less the maples in the city of St. Louis. Mr. Edward Orton, of Yellow Springs, Ohio, in sending me specimens in 1869, thus speaks of its injury: "I collected the Trochilium from the trunks of maples (*Acer saccharinum*) in the streets of the city of Springfield, Ohio, on Saturday, May 29, 1869. The insects were emerging in great numbers from the trunks of several trees. I took them on the trees, and even extricated some from the pupa cases —which remain fastened to the trees."

It is referred to quite frequently in the transactions of our western horticultural societies, and its work often confounded with that of the Flat-headed Borer. Mr. Merton Dunlap refers to its injury around Champaign, Ills.,* while Mr. Gennadius states that it has killed a number of maples on the University grounds at that place.†

It appears to be very generally distributed over the country, though as none of the older eastern writers on economic entomology refer to its injuries, we may infer that it does not attract the same attention in the Atlantic as it does in the Middle States.

The moths begin to issue from the trees the latter part of May, and continue to issue throughout the summer. The worms are found of all sizes, during this time, and throughout the winter.

I have always found the worms in such trees as had been injured, either by the work of the Flat-headed Borer, the rubbing of the tree against a post or board, or in some other way. Where the bark is kept smooth, they never seem to trouble it, the parent evidently preferring to consign her eggs to cracked or roughened parts. For this reason the worm is not found in the smoother branches, but solely in the main trunk. Whether the soap application will prevent the moth

under consideration in this genus. Subsequently Mr. Walker wrote: "*Ægeria* has been divided by Huebner and Newman into several genera, which differ as much from each other as they do from *Sphecia*, but they are here reunited, for the characters by which they are distinguished will not apply to the exotic species, and the latter, as yet, can hardly be divided into corresponding genera." (Brit. Mus. Cat. Lep., viii., p. 13)

And for this little freak of Mr. Walker's, his name, according to the fashion adopted in the List of Lepidoptera referred to, must supersede the describer's, as authority, to a whole string of our American species, many of which he perhaps never saw or heard of. Wherein lies the practical advantage or the justice of such a system, must be left for its advocates to discover!

* Trans. Ills. State Hort. Soc. 1872, p. 65.

† *Farmer*, Dixon, Ills., Feb. 1874.

from depositing her eggs, is not known: judging from analogy, probably not. Yet it will tend to keep the bark smoother, and, in being used to shield the tree from the other borer, it will indirectly shield it from this one. Mr. Gennadius recommends whitewashing the trunks, and filling up all holes and fissures with mortar, so as to render the bark as smooth as possible.

ÆGERIA ACERNI—*Imago.*—Head and labial palpi deep reddish orange, the former white in front of the eyes. Antennæ bluish black, the basal joint reddish orange in front [the terminal third sometimes luteous.] Thorax ochreous yellow, with the tegulæ in front touched with pale bluish black. Abdomen bluish black, varied with ochreous yellow [in well preserved specimens the hind edge of joints is distinctly yellow, and the third joint is always darker than those by which it is immediately bounded]; terminal tuft deep reddish orange. Fore wings with the margins and median nervure bluish black, dusted with yellowish; a large discal, bluish black patch; terminal portion of the wing ochreous yellow, with a blackish, subterminal band [often obsolete except at costa; this band, which is between the discal spot and apex, separates the opaque ochreous-yellow from the transparent part of wing, and when it is obsolete the separation is less marked], and the nervules blackish; the hinder margin bluish black, and the cilia deep fuscous. Hind wings with a black discal patch [small and subtriangular]; nervules blackish, and hinder margin blackish. Under surface of the body ochreous yellow, [often bright golden-yellow], with a bluish black patch on each side of the second abdominal segment. The middle and posterior tibiæ annulated with bluish black at their ends, the anterior blackish with the coxæ touched with reddish orange. All the tarsi touched with blackish above. [Costa of all wings ochreous or golden yellow.]—Clemens, *Proc. Ac. Nat. Sc. Phil.* 1860, pp. 14, 15.

Average expanse, ♀, 0.80; ♂, 0.75 inch. ♂ differs from ♀ in being generally lighter colored, with the fringes more golden, and the tips of anal tuft steel-blue.

Larva—Average length 0.60 inch. Color edematous-white. Body of uniform diameter to joint 11, from whence it tapers suddenly to anus, joint 12 being small and very short. Piliferous spots sub-obsolete, the usual hairs springing almost directly from the surface. Thoracic joints much wrinkled transversely; the middle joints gathered into two slight folds on their posterior third. A deep and conspicuous medio-dorsal longitudinal indenture, and a lateral substigmatal wrinkle. Stigmata brown and distinct, the last pair, on joint 11, being sub-dorsal and largest. Head small, horizontal; gamboge-yellow; the trophi brown and prominent, with sparse, rufous hairs. Cervical shield lighter colored and not well defined. Legs, and hooks on prolegs, rufous.

The medio-dorsal indenture, smallness of joint 12, and subdorsal position of the last pair of stigmata, are the most characteristic features. The thoracic and anal joints are sometimes dusky.

Many specimens examined.

Chrysalis—Unarmed, the anus being smooth and rounded.

THE RASPBERRY ROOT-BORER—*Ægeria rubi* N. Sp.

(Ord. LEPIDOPTERA; Fam. ÆGERIIDÆ.)

[Fig. 30.]

ÆGERIA RUBI:—*a*, Male moth; *b*, female moth.

The common borer, which works in the canes of raspberries and blackberries, and is frequently mentioned in entomological works, is a legless grub, the larva of a beetle (*Oberea perspicillata* Hald.) the female of which, according to Harris, lays her eggs singly on the stem near a leaf or small twig, but according to Mr. Wm. Saunders, of London, Ont., girdles the tops of young growing canes in two places, one about an inch from the other, and then between these rings, thrusts a single egg into the cane through a puncture, also doubtless made by her jaw.* But just as the Currant, the Grape, the Maple and many other plants are affected with moth larvæ as well as beetle larvæ, so the Blackberry and Raspberry have their lepidopterous borer, at once distinguished by its legs from the legless grub of the beetle above mentioned. For several years past, complaint has been made in several parts of the country† of a borer working in the root of these plants, and I last summer obtained evidence of its work as far west as Denver, Col., on the farm of Mr. J. Y. Dillon. It was first sent to me seven years ago by Mr. A. S. Fuller, of Ridgewood, N. J., and my late friend Walsh received other specimens in the spring of 1869 from Mr. Chas. Parry, of Cinnaminson, N. J.,‡ and succeeded in rearing the moth. Last spring, while visiting Mr. B. P. Hanan, of Kahoka, I learned that it was doing much injury to the Doolittle raspberries around Luray, and from specimens subsequently obtained and reared to the perfect state, proved it to be the same species that had been sent from New Jersey, and which has been captured on blackberries by my friend J. R. Muhleman, of Woodburn, Ills. Its life-history is

*Rep. of Ent. Soc. of Ont., 1873, p. 9.

M. Provancher (*Naturaliste Canadien*, VI., p. 123) suggests that this girdling is done to cause the cane to break off and enable the larva to transform within the broken cane, or else leave it and enter the ground for that purpose. The habit of the larva precludes the possibility of either of these hypotheses being correct. After the girdled tip is dead and broken off, the larva that hatched in it is burrowing in the still standing cane; and no stem-boring larva that I am acquainted with leaves the stem to transform in the ground. The most plausible explanation, it seems to me, is that the girdling in this instance is only one of the many provisions which insects are known to make to prevent the growing plant tissues from crushing or drowning the egg before it hatches.

†Trans. Ills. State Hort. Soc., 1867, p. 211; Trans. Iowa State Hort. Soc., 1869, p. 29.

‡*Am. Entomologist*, I, p. 167.

essentially the same as that of the lepidoptereous root-borers of the Peach and Grape.*

Major Muhleman thus communicates his experience with this borer:

It was in 1870, from July to September, that I first captured the moth, sometimes resting on the leaves and at other times leisurely flying about the blackberry bushes. At that time I had not noticed the effects of its work, though I had heard and read about the "winter-kill" of Lawton blackberries. In the spring following, viz. 1871, I found my bearing canes almost all dead, and during the summer of the same year noticed more moths. I then suspected it was that moth or its worm that caused the "winter-kill." In the spring of 1872 the last year's canes were again dead, and I determined to get, if possible, at the truth of the matter; I mowed the canes all down and then dug out the stools, cut them open lengthwise, and found the trace of the insect in every one; the result of my investigation was as follows: I found that the young worm upon hatching entered the growing cane at a place about 4, 5 and 6 inches above the ground, then worked downward, so that at the approach of winter it found itself in the roots, where it remained all winter; in the spring the half-grown worm then ascended through some other cane than the one in which it went down; at the height of about 4 inches above the ground I found several larvæ in different stages of growth, from $\frac{5}{8}$ of an inch to a full inch in length, the anterior portion of the worm invariably upward; this was in the latter part of April, for at the May meeting of the Alton Horticultural Society, I took a bundle of those roots with me to exhibit. I found at the height of 6 inches larger holes, evidently those of exit in old canes, with particles of the pupa shell in the orifice. I also believe that the insect is preyed upon by a parasite, as in some old canes I found some whole pupa with the hole of a parasite.

Mr. Muhleman found that they were more injurious to his Lawtons than to his Kittatinnies.

Mr. Theodore Engelmann, Mascoutah, Ills., has also had some sad experience with this borer, and very natually inferred, as he writes me, that it was the same insect that infests peach roots, for the reason that his raspberries were close to the site of an old peach orchard that had been ruined by borers. The inference was, however, very erroneous, and raspberries might be surrounded with peach trees infested with borers without receiving any injury from the same, and *vice versa;* for the two borers are specifically distinct, and the one never feeds on the food-plants of the other.

The worm attains an inch or more in length, is of a pale-yellow color, with dark, reddish-brown head. It dwells mostly in the root, but its burrow often extends several inches above ground. The moth (Fig. 30, *a*, ♂; *b*, ♀) has the front wings heavily bordered with rusty-brown, and the body prettily marked with yellow and black, and

*Reps. I, p. 48; III, p. 75.

slightly tufted. It is undescribed, and I name it from the genus of plants which it breeds in.

I know of no remedy for its injuries, other than its destruction wherever found. The moths issue in August and September, and probably much earlier. Mr. Parry found that the insect showed a preference for the Dorchester blackberry over all others.

ÆGERIA RUBI, N. Sp.—*Imago.*—Expanse, ♂, 1.00; ♀, 1.25 inch. Front wings transparent, with a broad costal border extending half the width of wing at base, a narrow discal spot, and more or less of the tip dull-ferruginous; the inner border, the inner longitudinal vein, the intermediate space toward posterior angle, and sometimes its whole length, of the same color; veins brownish within and black without the discal spot. Hind wings perfectly transparent, or rarely with a few sparse ferruginous scales; the transverse discal vein pale, the others pale at base, but black toward extremities; costa narrowly golden-yellow, becoming darker toward apex. Fringes dark-brown, those of hind wings appearing darkest by virtue of a dark wing border. Under surface somewhat paler. Abdomen stout, with a very slight anal tuft in ♀; a stouter one in ♂. Antennæ blue-black, not enlarging toward tip, quite pectinate in ♂. Palpi, a narrow ring around neck, the sides of the collar, a broad band curving across tegulæ and around the base of wings, a faint line across middle of thorax, two faint longitudinal lines between it and collar, legs, except outer base (sometimes whole length) of femora and tibiæ, hind third of abdominal joints, and a dorsal and lateral series of abdominal tufts or patches, (the dorsal ones, especially on 3d and 7th joints, most persistent and conspicuous)—all golden-yellow: the rest of body black. The orbits are of a somewhat paler-yellow, and the face either gray or bluish.

♂ differs from ♀ in the darker color of primaries, the narrower fringe of secondaries, the narrower ferruginous spot at apex of primaries, the more tufted abdomen, the broader and darker anal tuft, and the pectinate antennæ.

Described from 6 ♂'s, 6♀'s, bred from *Rubus*. Approaches nearest to *Trochilium marginatum* Harr., and *T. tibiale* Harr.,* from which it differs in the thoracic marks and the abdominal tufts.

Larva—Length 0.90–1.10 inch; diameter 0.18. Color pale-yellow. Head dark-brown, with a few whitish hairs; mandibles black, the other trophi paler. Cervical shield horny, pale-brown. Each joint with 8 pale, shiny piliferous spots, transversely arranged on 2, 3 and 12; the dorsal 4 quadrangularly arranged and the lateral 2 interrupted by stigmata on all the others. Thoracic legs slightly tinged with brown; prolegs, with the hooklets dark. Several specimens examined.

THE NORTHERN BRENTHIAN—*Eupsalis minuta* (Drury).

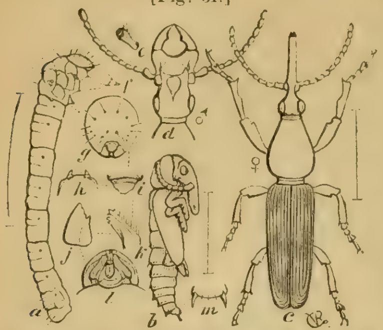
(Ord. COLEOPTERA; Fam. BRENTHIDÆ).

This odd-looking beetle is quite frequently met with, by the collector, upon oak trees, and especially under the partially loosened bark of oak stumps that have commenced to decay. It is very gen-

*Silliman's Am. Journ. of Sc., XXXVI, p. 309, (1839).

erally distributed over the States and in Canada, and is entomologically very interesting, as being the only species of its family occurring so far north, and as belonging to a group the true position of which has long perplexed systematists. This perplexity is, in a great measure, due to the fact that its larval structure has remained unknown, and that another larva has been mistaken for it. Dr. Harris,* as early as 1838, gave a very full account of the insect, but the larva which he describes as belonging to it, and which he received from the Rev. L. W. Leonard, of Dublin, N. H., differs very materially from the genuine larva, and I am now able, principally through the kindness of Mr. Wm. R. Howard, of Forsyth, Mo., from whom I first received specimens of its early stages, to give the correct natural history of this curious Brenthian, and to show how the original mistake of Mr. Leonard and Dr. Harris came about.

[Fig. 31.]



EUPSALIS MINUTA:—*a*, larva; *b*, pupa; *c*, female beetle; *d*, head of male do.; *f—l*, leg and head parts of larva; *m*, end of body of pupa, dorsal view.

As will be seen by the accompanying illustrations, the insect is distinguished by its elongate body, and especially by the snout projecting from the head in a straight line in front. In the male (Fig. 31, *d*) this snout is broad and flat, spreading toward the end, where it is surmounted with two powerful jaws. In the female it is narrow and cylindrical, generally longer, and not enlarged at the end. It varies considerably, particularly in the males, both as to length and breadth. The color of the species is mahogany-brown, the thorax smooth and highly polished, and the wing-covers strongly furrowed, shaded with deeper brown, and marked with narrow tawny-yellow spots. The species varies greatly in size, some specimens scarcely measuring ¼, others more than ½ inch in length; but contrary to the general rule with insects, the males are almost invariably the largest. The males of the Brenthians are known to fight desperately for the female, and, as has been remarked by Mr. A. R. Wallace,† it is interesting, " as bearing on the question of sexual selection, that in this case, as in the stag-beetles, where the males fight together, they should be not only better armed, but also much larger than the females."

The eggs are deposited during the months of May and June, and perhaps later, the female boring a cylindrical hole with her slender snout, and therewith pushing her egg to the bottom of the hole, as is

* See Ins. Inj. to Veg. p. 67.

† The Malay Archipelago, p. 482.

the habit of all snout-beetles. Mr. Howard thus describes his own observations of these insects: "It requires about a day to make a puncture and deposit the egg. During the time the puncture is being made, the male stands guard, occasionally assisting the female in extracting her beak: this he does by stationing himself at a right angle with her body, and by pressing his heavy pro-sternum against the tip of her abdomen; her stout fore legs serving as a fulcrum, and long body as a lever. When the beak is extracted, the female uses her antennæ for freeing the pincers or jaws of bits of wood or dust, the antennæ being furnished with stiff hairs and forming an excellent brush. Should a strange male approach, a heavy contest at once ensues, and continues until one or the other is thrown from the tree. The successful party then takes his station as guard. These contests sometimes last for hours, and are always repeated if the proper male is defeated, though not often if he is successful. I think it is by mere 'happen so' that the stranger passes by or runs across the busy couple, and if successful in routing his rival he takes the same care of the female as did the vanquished individual. The habits of these insects are much like those of the Curculio family. When disturbed they fold themselves up as well as they can and drop to the ground, where they feign death. They will soon 'come to' and hide beneath pieces of bark, stones or other rubbish, Curculio-like."

Mr. Howard is of opinion that this insect requires two years for its transformations, passing the first winter in the larva, the second in the beetle state. In some stove-wood (apparently red-oak) which was, in places, riddled by it as though pierced with different sized shot, I have myself found both larvæ of different sizes and beetles, in mid-winter; but it is difficult to draw conclusions from such facts, as many insects which are known to develop within a single year, are found in different states throughout the year, owing to irregularity of development and lengthened period during which eggs are being deposited.

The larva bores in all directions through the heart-wood. It is found most commonly in stumps or in felled trees the year after they are cut; yet both Harris and Mr. Howard concur in stating that it also works in living trees. Harris speaks of it as infesting the White oak, but it is, with us, equally common on the Black, Red and Post oaks.

The larva (Fig. 31, *a*) has the legs sub-obsolete, the thoracic joints swollen and the end of the body slightly swollen and blunt.

EUPSALIS MINUTA—*Larva.*—Length 0.55–0.75; diameter in middle of body 0.05 inch. Body almost straight, cylindrical, 12-jointed, with a few faint hairs only on prothorax and around anus: thoracic joints short, bent a little forward, swollen and broadly and deeply wrinkled, with two especially prominent swellings on top of joints 2 and 3, converging toward head, and having each a granulated rufous spot: the other joints

with about three dorsal transverse wrinkles; joints 5–9 subequal, as long as 1–3 together, twice as long as 4; 10–12 diminishing in length, slightly swollen, the anus retracted: 6 very small 3-jointed thoracic legs (*f*), the terminal joint being a mere bristle: stigmata quite distinct and brown, the first pair much the largest, between the fold of joints 2 and 3; the others on anterior fifth of joints 4–11, the last pair more dorsal than the rest. Head pale yellow, darker around mouth; rounded, more or less bent over the breast, with sparse, stiff, pale hairs springing from elevated points: ocelli, none; antennæ not visible, unless a dusky prominence lying close between mandibles and maxillæ be called such; labrum (*i*) small with two depressions and other inequalities, the margins slightly angular, allowing jaws to closely fit around it; jaws (*j*) stout, triangular, the inner margin produced at middle into a larger and smaller tooth, and with a slight excavation near tip; maxillæ (*k*) long, with but a short, horny cardinal piece, the palpi apparently 2-jointed and with difficulty resolved, on account of three or four other prominences around them; garnished on the inside with a close row of stiff hairs and on the outside with two stouter hairs; labium (*h*) large, oboval, the palpi placed in front and 2-jointed.

Eight specimens examined.

Pupa.—Average length 0.40 inch, with the antennæ curled back over the thorax, the seven or eight terminal joints, each with a more or less distinct, forwardly-directed, brown thorn; the snout lying on the breast and varying according to sex; abdominal joints with a more or less distinct row of small thorns on the posterior dorsal edge, the last joint with a more prominent thorn directed backward in a line with the body.

Four specimens examined.

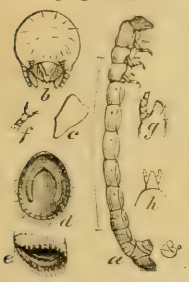
The entomological reader will notice that, in its larval and pupal characters, this insect shows strong affinities with the true Snout-beetles (*Curculionidæ*), and there can no longer be any doubt as to the real position of the Brenthians, in a natural system of classification. They have rightly been considered to form a tribe (*Brenthides*) of the Snout-beetles proper, but are placed in a family by themselves by modern coleopterists, and bring up the rear of Mr. G. R. Crotch's new "Check list of the Coleoptera of America, north of Mexico." Our species, under consideration, is treated of by Harris, Fitch and other earlier writers, under the vernacular name of "Northern Brenthus," and the scientific name of *Brenthus* (or *Arrhenodes*) *septentrionis* Herbst. It has been described under several specific names, as *maxillossus* by Olivier; *minutus* by Drury. This last has priority over all other names, but as the description was made from a diminutive individual, subsequent authors had doubts as to the species intended, and very generally ignored the name in favor of that given by Herbst. Dr. G. H. Horn, as late as 1872, in a paper on the *Brenthidæ* of the U. S,* adopted Olivier's name; but there seems to be no question that the species described by Drury was our northern species. Hence, according to the strict law of priority, his name

* Trans. Am. Ent. Soc., vol. iv., p. 127.

must be adopted. But the old genus, *Brenthus*,* has also been subdivided; and as our insect, by this subdivision, falls into its last new genus, the specific name must be altered to conform thereto. Thus it is that the old familiar *Benthus septentrionis*, employed for so many years in works both popular and technical, becomes *Eupsalis minuta*; and thus it is that entomology, more than any other department of zoölogy, is cursed with a constant chopping and changing of names, principally because her devotees have so far failed to adopt some simple rules for guidance that shall give more stability, and, in a measure, put a stop to this everlasting flux in her nomenclature.

Now, how did Mr. Leonard, and through him Harris, fall into the error of giving, as of the larva of our Brenthian, a description which, though quoted without remark by most subsequent authors, was called into question by Chapuis and Candèze,† and proves to be erroneous? The explanation is simple, and the error comes of stating as unqualified fact that which rests on no absolute proof. Boring in the same wood, and making holes that are undistinguishable from those made by the Brenthian larva, I have found a larva (Fig. 32, *a*) which, while bearing a general superficial resemblance to it, is yet easily distinguished by having distinct antennæ, conspicuous thoracic legs, an anal proleg, and a curious horny excavation at the end of the body (Fig. 32, *d*, *e*). Indeed, it answers fully to the description given by Harris as of the Brenthian larva, and which I herewith quote :—"When fully grown, the grub measures rather more than an inch in length, and not quite one-tenth of an inch in thickness. It is nearly cylindrical, being only a little flattened on the under side, and is of a whitish color, except the last segment, which is dark chestnut-brown. Each of the first three segments is provided with a pair of legs, and there is a fleshy prop-leg under the hinder extremity of the body. The last segment is of a horny consistence, and is obliquely hollowed at the end, so as to form a kind of gouge or scoop, the edges of which are furnished with little notches or teeth. It is by means of this singular scoop that the grub shovels the minute grains of the wood out of its burrow." Subjoined will be found a more detailed description:

[Fig. 32.]



UNDETERMINED TENEBRIONID:— *a*, larva; *b*, front view of head; *c*, *f*, *g*, *h*, mouth parts; *d*, *e*, concave end of the body, full and side views.

* *Brenthus* proper has the thorax depressed and deeply channeled. *Eupsalis* has the thorax convex above, and not channeled. "This genus represents the Arrhenodides of Lacondaire, distinguished by the conical thorax not compressed in front, the antennæ moderately robust, but not terminated by a club. Head transverse, mandibles prominent. Among the genera of the group, *Eupsalis* is known by its short and broad rostrum, the broad head, the femora slender and cylindrical at base. It is closely allied to Arrenhodes, in which our species had been placed, but differs by the hind angles of the head being effaced, and the surface shining."—Horn, *loc. cit.*

† *Mem. de la Soc. Roy. de Liège*, VIII., p. 536, 1853.

———— ?—*Larva* (Fig. 32)—Length 0.90–1 inch. Body 12-jointed, proportioned, and with about the same curve as in *Eupsalis*, but more polished, less wrinkled, more dusky, especially toward each end; the thoracic joints not swollen, and less relatively short, the first extending slightly above the head, like a hood; jts. 10, 11 and 12, each with two narrow, transverse, horny, brown, dorsal ridges, armed with minute thorns, the last ridge on 12 subobsolete: anus on a ventral swelling, between 11 and 12, having a transverse slit, the hind edge of which is horny and brown, and used as a proleg: 12, at end, horny, brown, obliquely truncated above, deeply concave, with two narrow, roughened, darker marks within the concavity, distinctly separated below but meeting above; the edges notched and furnished with stiff, yellowish hairs; thoracic legs with the tarsi ornamented with stiff points below, and terminating in a simple claw; stigmata normally arranged. Head and all the tropi, except jaws, sparsely garnished with stiff hairs; of same general form as in *Eupsalis*, but darker, the lobe of maxillæ (*g*) reaching to tip of maxillary palpi, which are 4-jointed; antennæ (*f*) in front, just above mandibles, 4-jtd, inclusive of bulbus, jts. subequal in length, the terminal one very narrow and appearing as a fleshy hair; labium (*h*) slender, with 2-jtd. palpi; mandibles (*c*) triangular, and but slightly irregular on the inner edge. Described from three specimens.

We do not yet know what this larva will produce,* but it evidently belongs to the *Tenebrionidæ*, a family which includes our common Meal-worm (*Tenebrio molitor*), and widely separated from the Brenthians.

THE JUMPING SUMACH BEETLE—*Blepharida rhois* (Forst.)

(Ord. COLEOPTERA; Fam. CHRYSOMELIDÆ†).

Sumach, on account of its tanning and coloring properties, is coming into increasing use in this country as an article of commerce. Large quantities are imported every year from Europe by New York and Philadelphia houses, and in 1869 the importations are said to have reached 11,832,451 pounds. Now analysis shows that some of our sumachs possess as much tanning property as the European, and they are so abundant in the South-west that it seems strange that we should have to import any of the prepared article from abroad. There must be a good reason for the fact, however, and it is doubtless to be found in the greater care in which the European article is prepared for market. Sicily sumach is made of the stems and leaves only, which are gathered and carefully dried in the shade, and ground in a primitive mill, or cut in a hay-cutter; the stems are afterward separated by winnowing, and the ground leaves neatly packed in bags. The preparation of American sumach, as an industry, is, however, steadily

* I have bred *Meracantha contracta* (Beauv.) from a larva having a somewhat similar, but smooth-rimmed, anal excavation, and from its narrowness and size I strongly suspect that the above-described larva belongs to the closely allied genus *Strongylium*, and will produce *S. tenuicolle* (Say) which I find on felled oak.

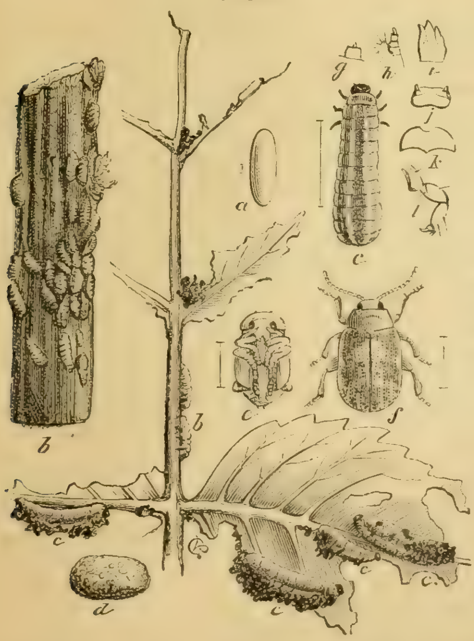
†The genus *Blepharida* forms the last genus of the Tribe *Halticini*, in the Sub-family *Galerucides*, and is distinguished from all the other genera of the Tribe, by having the claws bifid—See Crotch's "Materials for the study of the Phytophaga of the U. S.;" Proc. Ac. Nat. Sc., Phil., 1873.

increasing, and Virginia is reported to have seventeen sumach mills which turn out annually 6,000 tons, on which $60 per ton are realized.

In Missouri several parties have entered into its preparation, from the wild shrubs; but no one, I believe, has yet cultivated sumach, though it may be cultivated as easily as corn, by cutting down to the ground in the fall, and harvesting from the sprouts sent up each year. Wm. Neison, of Fox Creek, has realized several hundred dollars by preparing it; but Mr. A. W. McPherson of Springfield, who once went into the business quite heavily, found it unremunerative.

There are three species possessing an economic value, found throughout the State, and especially in the southern part on our prairies and glades. These are, the Stag-horn Sumach, (*Rhus typhina*), the Smooth Sumach (*R. glabra*) and the Dwarf Sumach (*R. copallina*). Should they ever acquire greater money value than they now possess, and come to be cultivated, there will be one serious drawback, in the injuries of the beetle under consideration. Indeed, as it is as fond of the Venetian Sumach (*Rhus cotinus*, commonly called Smoke-tree or Purple-fringe, and cultivated for ornament) as of the three indigenous species just enumerated, it must be even now classed with our insect pests, and it will be well to set forth its habits, especially as they have not heretofore been given, and the insect is not mentioned in the works of Harris, Fitch or Packard.

[Fig. 33.]



BLEPHARIDA RHOIS:—*a*, egg; *b*, *b*, egg masses, covered with excrement; *c*, *c*, *c*, *c*, larva; *d*, cocoon; *e*, pupa; *f*, beetle: *g*, *h*, *i*, *j*, *k*, *l*, mouth parts of larva.

As soon as vegetation starts in spring, the beetles, (Fig. 33, *f*), which had passed the winter, as such, in sheltered situations, may be seen upon their food-plants, sometimes in great numbers, and generally coupled. Though not as shy and active as many of the smaller flea-beetles, they yet jump with alacrity by means of their thickened hind thighs—a fact which has been doubted by some entomologists, but certainly by none who have known the insect in life. The wing-covers are of a bright mahogany-brown, marked, as in the illustration (*f*), with white, and the head and thorax are of a bright shiny green. In cabinet specimens these colors fade, and the

general tint is more yellowish or rust-colored. Very soon after the appearance of the beetle the stems and branches of the plants named, if carefully examined, will be found more or less covered with little elongate pellets of excrement, (*b*, *b*,) dark when fresh, but becoming paler and grayish-brown when dry. These pellets are sometimes so numerous as to form one large mass completely covering the stem or branch; at other times, and especially when on the leaf or leaf-stem, they are single. If more critically examined, they will each be found to contain five or six pale yellow eggs (*a*) mostly laid side by side, and separated from the excrement by a thin papery layer of a whitish, opaque substance. These eggs give birth,* in a very few days, to little dark yellow worms with a conspicuous black head, and shiny plate on the first joint, six long, black, thoracic legs, and a pale anal proleg.

This worm no sooner begins feeding than it besmears its back with its own excrement. It grows apace, becoming paler with age, and showing paler stripes along the back (*c*), which it continues to cover, more or less completely, with its soft blackish dung, thereby presenting a most repulsive appearance. This filthy habit has no doubt, for object, the moistening and protection of the soft body from the sun's hot rays, for in cloudy and rainy weather, and in the breeding cage, the animal is far less careful about covering itself, and, as we shall presently see, it is not found during the intense heat of summer. The dung is pushed forward on the back purely by the contraction and extension of the different joints, the anal slit being transverse and excreting upward.

After thrice shedding "its skin," each time anchoring itself to the leaf, head downward, for the purpose, this worm acquires full growth and descends into the ground, where it forms a somewhat oval cocoon (*d*) in the construction of which it again uses its dung, mixing with it a little earth to add consistency, and perhaps also employing a fluid from the mouth. Here, in the course of a fortnight, it becomes a pupa (*e*), and in a few days more the beetle works its way to light. A second brood of worms follows the first, there being scarcely any intermission between the two broods, as the later individuals of the first have generally not disappeared when the earlier individuals of the second begin to hatch. The second brood disappears, however, during the fore part of July, and nothing more is seen of the insect till the following September, when the worms which had remained buried, without change, through the hotter months of July and August, transform and give forth the second and last brood of beetles.

* I have noticed that as soon as it leaves the egg-shell, the young larva frees itself from a delicate pellicle which surrounds it, much as is known to be the case with so many Hemiptera and Orthoptera.

These feed on through the fall, and, hibernating, recommence, in spring, the annual history just told.

This insect is so abundant that the sumachs are, in some years, completely denuded over vast extents of country. In July of last year, though the animal itself was not to be seen, I found abundant evidence of its work through Kansas, Texas, Indian Territory and Colorado. It feeds alike on all the sumachs I have mentioned; but is not so frequently found on the Fragrant Sumach (*R. aromatica*, known in different parts of the State as "French Hazel," "Stinkweed," "Polecat-weed," etc.,) and not at all on the Poison Ivy, (*R. toxicodendron*).

REMEDIES.

The Smoke-tree may be protected from the injuries of this insect by jarring the beetles, in early spring, into pans of water, or by strewing the ground lightly with straw, then starting a ring of fire on the outside, and jarring the beetles into it. If the worms have been allowed to hatch, the Paris-green mixture will soon dispose of them.

BLEPHARIDA RHOIS.—*Egg*—Pale yellow, ellipsoidal, 0.05 inch long, ¼ as wide; translucent.

Larva.—Average length 0.50 inch when full grown. Body 12-jointed, with but a very slight subjoint; smallest and narrowest on joint 1, enlarging thence gradually to 12th, which is rounded and somewhat bulbous. Dorsum with about three faint transverse wrinkles to each joint. Color translucent gamboge-yellow, with six longitudinal lines of a paler, brighter, opaque yellow; two of these dorsal, straight, and mostly obsolete on thoracic joints; and two each side, sinuous and slightly raised, the lower in a line with stigmata, the upper parallel to it. The spiracles in normal position, consisting of small, dark-brown, raised, circular annuli, the first pair rather largest, and on a subventral fold between joints 1 and 2; the others in middle of joints 4–11. A lateral brown, polished, crescent mark just above legs on joints 2 and 3, and numerous minute brown papillæ most conspicuous on thoracic joints. *Head* small, polished, black; the sutures paler; a few short paler bristles around trophi, which are inconspicuous; Epistoma broad, with a Y-shaped depression in the center; labrum (Fig. 33, *k*) white and excavated in front; antennæ (*g*) naked, 2-jointed, the basal joint very stout and truncate, the terminal joint a mere nipple; mandibles (*i*) 4-toothed, the outer one small; maxillæ with a few bristles on inner lobe, and the palpi (*h*) naked and 4-jointed; labium (*j*) transversely reniform, the palpi naked and 2-jointed. Cervical shield rather darker than body and mottled with brown. Legs (*l*) increasing in size from first to third pairs, mostly armed with a few pale stiff hairs, the coxæ stout, and the tarsi consisting of a pale, fleshy, tractile tubercle, surmounted by a curved hook. An anal retractile pseudopod, which, when fully exserted, is divided into eight or more lobes, and much expanded. Anal slit transverse. The young larva differs only in having the cervical shield black. Many specimens examined.

Pupa—Of the normal Chrysomelid form, yellowish, with the eyes and tips of jaws dark, and two small anal projections.

The beetle is so variable in the disposition and size of the red-brown markings that many of its more marked varieties have been described as distinct species, as the following synonymy by Mr. Rogers, which I quote from the Proceedings of the Philadelphia Academy of Natural Science (1866, pp. 29 and 30), will show :

Blepharida rhois.—Oval, convex, ferruginous ; head and thorax yellow ; elytra with eleven rows of large punctures, irregularly mottled, sometimes vittate with yellow and ferruginous ; margin always broadly yellow ; antennæ black, base piceous. Length .25–.30.

Chrysomela rhois Forst. Cent. Ins. 1, 21. Hübn. Naturf. 24, St. 40. Oliv. Enc. Meth., 5, 720.

Altica Virginica Frölich, Naturf. 26, 129, 54.

Haltica rhois Illig. Mag. 6, 161.

Chrysomela stolida Fabr. Ent. Sys. 1, 318. Syst. El. 1, 435. Oliv. Enc. Meth. 5, 700.

Haltica stolida Illig. Mag. 6, 161.

Chrysomela meticulosa. Oliv. Ins. 91, 531, tab. 6, fig. 91. Locality—Middle States, Southern States, Nebraska and Upper Mississippi.

"JIGGERS" or HARVEST-MITES:—*Leptus irritans* Riley (to the right), and *L. Americanus* Riley (to the left).

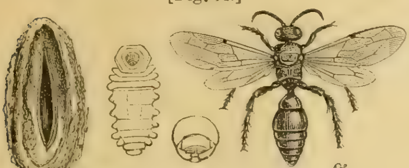
BENEFICIAL INSECTS.

THE UNADORNED TIPHIA, or WHITE GRUB PARASITE—*Tiphia inornata* Say.

(Ord. HYMENOPTERA; Fam. SCOLIIDÆ.)

Many animals, as the badger, weasel, skunk, marten; some birds, as the crow; and some predacious insects, as the different Ground-beetles (*Carabidæ*), and perhaps the larvæ of some Breeze-flies (*Tabanidæ*) attack and devour the common White Grub (*Lachnosterna quercina*, Knoch). But, so far, no true parasite of its own class has been known to prey upon it, though it is at times extensively destroyed by a parasitic cryptogamic plant (*Torrubia militaris*,* Tul. Fig. 35.)

[Fig. 34.]



TIPHIA INORNATA:—*a*, perfect fly, female; *b*, enlarged head of larva; *c*, larva, ventral view; *d*, cocoon cut open.

I wish to call attention, however, to an insect which I have named the "White Grub Parasite," and which well deserves the title, as it kills and devours great numbers of the well-known scourge of our pastures and meadows.

One can scarcely dig for half an hour in any soil in this part of the country, without meeting with a curious egg-shaped cocoon (Fig. 34, *d*), of a pale golden-brown or buff color, and with a soft exterior surface, in touch as well as in color, reminding one of the punk used by dentists. Upon cutting this cocoon open, it will be found to consist of about a dozen delicate layers, the outer ones soft and loosely spun, the inner ones more and more compact and paler in color. Within this cocoon, if fresh, there will be found a whitish grub (Fig. 34, *c*) which, though lacking legs has the joints of the body, at the sides, swollen so as to look like the fleshy pseudopods possessed by many larvæ. The pupa I have not yet had an opportunity of figuring

* Mr. W. R. Gerard, Poughkeepsie, N. Y., is inclined to think, from dried specimens I sent him, that it may be the *cinerea* Tulasne.

and describing, but the perfct fly (Fig. 34, *a*, ♀), which may be called the Unadorned Tiphia, issues in due course of time through a ragged hole in the large or blunt end of its cocoon.

From having repeatedly found the head parts of some Lamellicorn larva attached to these cocoons, I had long suspected that such larvæ formed the food of this Tiphia, and on carefully examining these head-parts I recognized them as belonging to the common White Grub. But all doubt as to this fly being parasitic on said White Grub ceased when, in 1872, Mr. A. W. Smith, of St. Louis, brought me a number of the cocoons which he had taken from a low part of his farm on the Illinois bottom, where the White Grub was very thick, and the yellow cocoons so numerous as to attract attention.

The genus *Tiphia* is characterized by having the maxillary palpi long, and composed of unequal joints, and by the second joint of the antennæ being received into the first, which hides it. The insects belonging to it, like all fossorial or digger-wasps, are known to burrow in the ground, but their larval habit has not heretofore been known. Mr. Fred. Smith, of the British Museum, has surmised,* from certain observations he made, that the European *Tiphia femorata* is parasitic upon *Aphodius*—a genus of Lamellicorn beetles whose larvæ resemble the White Grub in general appearance, and feed for the most part on dung, entering the earth to transform. The surmise is doubtless correct, judging from the habit of our Unadorned Tiphia.†

The parent fly must be endowed with a rare instinct to enable it to find the under-ground food for its progeny, and consign therewith an egg. Judging from analogy, she fastens this egg to the anterior ventral part of the White Grub, where the latter's jaws can not reach it; and her larva, with its head embedded, and clinging as tenaciously as a bull-dog to the muzzle of a fated ox, feeds externally on its victim, and, after rapidly appropriating all the softer parts, spins the cocoon already described—the more horny head-parts of its prey naturally adhering to the outside, or first-spun layer. The perfect insect issues by gnawing, with its strong arcuated jaws, a hole near the blunt end of its cocoon.

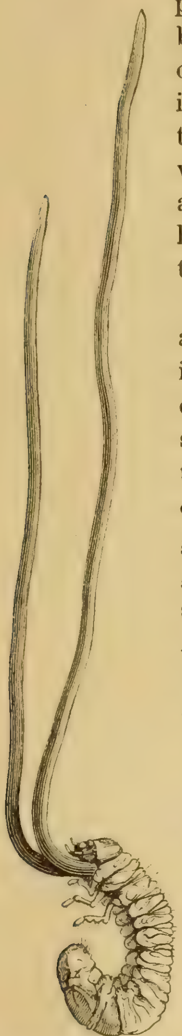
The Unadorned Tiphia is polished coal-black in color, sometimes with a faint bluish hue, but without any paler markings. The body,

* Entomologist's Annual, London, 1871, p. 57.

† *Scolia* (the typical genus of the family), 2-*cincta* Fabr., which occurs both in this country and Europe, makes its burrows in sand-banks, to the depth of eighteen inches, and is supposed to use the Orthopterous locusts (*Locustidæ*) for food—*Westw. Intr.* II. p. 211. *Scolia flavifrons* attaches its egg to the venter of the larva of a common European Lamellicorn larva (*Oryctes nasicornis*) in the bark beds (Vallonea) of hot-houses; and Passerini, as quoted by St. Fargeau (*Hym.* III., pp. 504—517), describes its larva and cocoon, which are much like those of *Tiphia*, and explains how the latter must be formed by the mature larva, as within it there are found no remains whatever of its prey.

except a small scale at the base of the front wings, is minutely punctate, and covered more or less with sparse, stiff, pale-yellow hairs, thickest on the under side, on the hind edge of the abdominal joints, and at the tip of the abdomen. The wings are dusky, with smoky, yellowish-brown. It varies very much in size, the cocoons ranging from 0.35 to 0.80 inch in length, and the flies from 0.35 to 0.68 inch. This variability in size is owing, doubtless, to the age and size of the White Grub on which it develops, the larva having the power to adapt itself to the conditions to which it is born, and from which it can not escape except by death, or maturity. The body in the male is narrower than in the female, and ends underneath in a single spine, though in most species of the genus, according to Westwood, it ends in three. The front wing in the male is also less notched at the end than in the female, and has the marginal cell closed instead of open at the extremity.

[Fig. 35.]



WHITE GRUB FUNGUS.

One would suppose that an insect which develops at the expense of the White Grub, hidden as it always is under-ground, would itself be well shielded from enemies. Yet such is not the case, and I have bred several specimens of a parasitic beetle belonging to the curious genus *Rhipiphorus** from the *Tiphia* cocoons. A curious chapter might be written on the singular parasitism of this genus of beetles, and of the genera *Meloe* and *Stylops*, all which have somewhat similar habits, and undergo what is known as hypermetamorphosis (see Rep. V, p. 15); but in this connection it suffices to say that from what Mr. Smith, and other observers have recorded of the parasitism of *Ripiphorus paradoxus* on the common Yellow-jacket (*Vespa vulgaris*), that the newly hatched *Rhipiphorus* larva is six-legged; that, piercing a hole in the skin of the Wasp-grub, it eats its way into the interior, where it remains till its victim is full grown and has formed its cocoon; that it then casts its skin (and its legs with it), issues from the body of the wasp larva, and, fastening to the second body-joint of the same, rapidly appropriates its substance—going through its transformations within, and gnawing its way out, as a beetle, through the wasp cocoon. The eggs of the *Rhipiphorus* are probably deposited on flowers frequented by *Tiphia* and other wasps, to the bodies of

* The *Rhipiphorus* [*Emmenadia*] *pectinatus* Fabr., var. known as *ventralis*.

which the little hexapod larva fastens. Thus, the mother wasp, while bent on seeking prey for her own parasitic larva, carries with her, underground, and all unconscious of the fact, the seed of destruction to her own offspring. Her larva must also be preyed on by still another enemy, as I have a cocoon riddled with small round holes.

TIPHIA INORNATA—*Larva* (Fig. 34, *c*).—Length 0.25–0.50 inch when full grown; greatest diameter ½ the length; largest in middle: 12 joints and a subjoint, exclusive of head. Head (Fig. 36, *b*) bent over on the breast. Color translucent-white, with a broad, transverse, opaque wrinkle around each joint; on all the stigmata-bearing joints except 1, this wrinkle is constricted into two ellipsoidal pieces dorsally, strongly bulging laterally into semi-oval tubercles, like pendopods, and subobsolete ventrally. Labrum edged with brown. Stigmata small, circular, brown, and placed on posterior part of joint 1, and on anterior part of joints 4–11. Anal slit transverse.

Described from 13 specimens. The color becomes more yellowish in alcohol.

Imago.—This insect is very variable in size, 2 ♂, 7 ♀ specimens which I have bred from the cocoon ranging from 0.35 to 0-68 inch in length of body. The wings are either very faintly or more deeply smoky-yellow. The color is jet black, but on my largest ♀ a faint bluish or purplish hue is noticeable. In studying by the light of the specimens before me, Say's three descriptions which follow, I am forced to the conclusion that they all refer to but one species. Certain features common to all the specimens are curiously omitted in one or other of the descriptions, and inserted in one or both the others, while every feature mentioned belongs to the one species taken in its variations. It becomes a question, in such a case, which name to use, but I employ the first because it is appropriate, and seems to have been the only one used by subsequent authors.

"*T. inornata.*—Black, immaculate; wings yellowish, fuliginous.

"Inhabits Ohio and Pennsylvania.

"Head punctured; antennæ piceous, paler toward the tip; mandibles piceous, blackish at tip; thorax punctured, wing-scale and posterior margin of the first segment impunctured, edge of the latter piceous; metathorax with three longitudinal, slightly elevated lines; posterior edge also slightly elevated into an acute line; feet hairy; tibiæ and tarsi more or less piceous; abdomen, particularly behind, hairy.

"Length three-fifths of an inch."—Say (Am. Ent. I, p. 223.)

"*T. transversa.*—Blue-black, somewhat hairy.

"Inhabits Indiana.

"Body black, with a slight bluish or purplish reflection; with numerous whitish hairs; immaculate, punctured; antennæ black, opaque; mandibles piceous at tip; palpi fuscous; wings a little dusky, hyaline, nervures black; apical lines of the second cubital cellule transverse, rectilinear; metathorax each side striated, above with three slightly elevated, longitudinal lines and a posterior transverse one; abdomen, first segment narrower than the second, somewhat gibbous above and flat beneath, the incisure indented; remaining segments more hairy, ciliated; tibiæ and tarsi with silver hairs.

"Length nearly half an inch."—Say (Am. Ent. I, p. 385.)

"*T. tarda.*—Body polished, black, punctured; mandibles piceous in the middle; metathorax with three longitudinal lines, and the minute lines on the margin of the posterior declivity very regular and obvious; wings tinged with honey-yellow; nervures brown; stigma black; incisure of the first abdominal segment not very much contracted; second segment at its basal margin with the minute, longitudinal lines very regular and distinct; palpi, dull piceous.

"Inhabits Indiana.

"Length about three-tenths of an inch.

"The smallest species I have seen, and may be distinguished from its American congeners by its size. The male has the metathoracic lineations more distinct. It is smaller than the *femorata* of Europe."—Say (Am. Ent. II, p. 742.)

INNOXIOUS INSECTS.

THE DOMINICAN CASE-BEARER—*Coscinoptera dominicana* (Fabr.)

(Ord. Coleoptera; Fam. Chrysomelidæ.)*

[Fig. 36.]

Coscinoptera dominicana:—*a*, larva extracted from case; *b*, do. with case; *c*, beetle showing punctures; *d*, same natural size; *e*, egg enlarged; *f*, head of larva, underside; *g*, head of male beetle; *h*, jaw of same; *i*, eggs natural size; *j*, leg of larva; *k*, jaw of same; *l*, maxilla of same.

Having just given the hitherto unrecorded habits of our largest flea-beetle, and shown how it affects the sumachs, and how it utilizes its excrement as a covering for the egg and the larva—albeit in a rather slovenly and disgusting way; I have deemed this a proper place to say a few words about another beetle, not unfrequently found on sumachs, and which, to some extent, uses its excrement for the same purposes, but displays far more talent and taste in the manner.

Though the beetle (Fig. 36, *c* enlarged, *d* natural size) is tolerably common all over the country, its natural history has so far not been recorded. It has been well christened, for it is neither ornate in color, nor prone to make itself conspicuous, like its jumping cousin just treated of. It is, in fact, with the exception of the labrum, which is yellowish-brown, of a uniform black color, the upper surface, and especially the elytra, deeply and closely pitted or punctate, and sparsely covered with ash-gray pubescence; the under surface much more thickly covered with the same colored pubesence. The male is distinguished from the female principally by his larger jaws. (*g*, *h*)

During the summer months this beetle is quite frequently beaten by the collector not only from Sumach but from different shrubs, or young trees, such as Oak, Sassafras, Plum, Apple, Rose, etc. Being

*The genus *Coscinoptera* belongs to the Tribe *Clythrini* of the Subfamily *Melolonthides*, and is distinguished principally by its irregularly punctate elytra.

quite active and shy, and having, in common with so many other beetles, the habit of dropping to the ground upon the least disturbance, it is easily overlooked and rather difficult to capture. Its food consists of the more tender leaves of the several plants it inhabits, into which leaves it gnaws numerous round holes.

The eggs of this insect were first brought to me by Miss Murtfeldt, and it was some time before I could ascertain their parentage. They are of not unfrequent occurrence, and are found as early as the end of May attached to all sorts of plants, especially evergreens, in small lots of from two to ten (*i.*) Most beetles belonging to the closely allied genera *Cryptocephalus* and *Clythra* cover their eggs with excrement, and Rosenhauer* and other authors have minutely described how the egg is held horizontally between the hind tarsi while treated with its stercoraceous covering, which is added in small, thin, curved layers, and pressed into various patterns by the anus. In many species of the genera mentioned, the female is provided at the tip of her venter, with a little cavity into which she sticks this egg, if disturbed before the operation of covering is completed. Most of the species, after thus protecting their eggs, simply let them fall to the groud ; while a few, like our Dominican species, attach them carefully by a delicate, silk-like stalk, made of the same excrementitious matter. This stalk is analogous to that by which the eggs of our Lace-wings are attached, but, though shorter, it is less stiff, so that the eggs, instead of standing erect, always droop more or less. In the genus *Chlamys* the egg is anchored to the leaf, but by an extremely short peduncle.†

The egg of our species is 0.03 inch long, narrowly oval and thrice as long as wide. It is whitish, translucent and very soft. Its covering is of a deep brown, and very beautifully molded, with seven or eight thin ridges diagonally crossing each other at regular intervals. The excrement from which it is made is either quite sticky in itself, or is mixed with some sticky secretion : indeed, in the strict sense of

* Ueber die Entw. und Fortp. der Clythren und Cryptocephalen. Erlangen, 1852.

† I have frequently reared *Chlamys plicata*, Oliv., from the larva, which may be found feeding on Oak, Sycamore and Blackberry. The figure (37) of the case which I have introduced is too heavy at the top: it should be more pointed and curved downward. The beetles are found in early spring, and the eggs, which Miss Murtfeldt first succeeded in obtaining, are perfectly oval and of a highly polished Venetian-red, and look like little pieces of coral. They are taken between the hind tarsi and treated to a covering of dark, sticky excrementitious matter, very much in the same way as described in *Coscinoptera*. The covering is, however, of simple and uniform surface. It is somewhat bell-shaped, the upper end being largest, squarely docked, and slightly depressed so as to form a circular rim around the margin. The small end is anchored to the down of the leaf by a few gummy shreds. If the female is disturbed while covering the egg, she sticks it in the ventral cavity and runs away. It would appear from Miss Murtfeldt's observations that while uncovered this egg is greedily sought by the males, which devour it; but that when once covered they never touch it. How essential to the species is a little bit of dung, in the light of this observation! The young larva, as in *Coscinoptera*, cuts its way out at the

the word it can not be called excrement, as it is evidently secreted for the especial purpose of oviposition, and differs considerably from the pure excrement. To attach and cover one egg requires about a half hour's time. The operation is generally performed during the night, and I have known the same female to fix thirteen between a May sunset and sunrise. The covering is undoubtedly intended to shield the egg from marauders, and especially from the depredations of the males, judging from the facts recorded in the subsidiary note, on *Chlamys*.

In from fourteen to eighteen days the egg hatches, the young larva opening its way to the light of day through the attached end of its egg-shield, and doubtless cutting itself loose from its anchorage and tumbling to the ground. The covering which had protected the egg now serves as cradle to the young larva, which pokes out its head and legs and craws actively about by a series of curious jerks, with the egg-case hoisted in the air—withdrawing the exposed parts upon the slightest disturbance.

The Chrysomelians so very generally feed on the green and growing leaves of plants that they have been popularly characterized as "Leaf-feeders." Our present subject, however, departs from the habit of the family, as do many of its close connections, in that it feeds on dead and decaying leaves in its earlier larval days.* Nor does it seem to be particular as to the kind of leaf, as I have furnished it with sumach, sassafras, oak, apple and other kinds, and it fed alike on the parenchyma of all, but would not touch the green leaves of the same plants.

The larva, though growing slowly, is soon cramped in the cradle of its birth, and must needs have more room. This it gets by mixing particles of earth into a mortar, by means of saliva, and plastering the mixture with its jaws to the rim formed by the opening of the case. As the animal increases in size its case thus enlarges from the bottom, the material being molded into irregular longitudinal ridges, and always surmounted at the top by the old, partially covered egg-

attached end, and makes a house of the egg-case, gradually adding to it, with age. This apical egg-case, may always be distinguished by its darker color, and finer and more glutinous material, from the rest of the larval house, which is more or less covered with the leaf-down of its food-plant, and is, in consequence, on the Sycamore, quite grayish and pilose. The larva, extricated from its case, is well represented in the illustration (37), though the end of body should be more curved underneath. It eats irregular holes in the leaves, and when about to transform, securely fastens the case to the same. The pupa is of a brilliant flesh color, and characterized chiefly by having at the end of the body two short, blunt, dorsal tubercles directed upward and outward, and two terminal processes in a line with body, more proximate and pointed. The beetles issue through a lid, smoothly cut from the pointed free end of the case, and they feed on the same plants by skeletonizing the leaves.

*Some Clythrid larvæ even feed on dead animal matter.

case (*b*). The color of this larval house, in our insect, is pale grayish-yellow, and it looks very much as though made solely of dried earth. Indeed, though in some allied European species, as Géné and Rosenhauer have abundantly shown, the larval case is composed mainly, if not solely, of the animal's fæces, in our Coscinoptera it is composed principally of earth or fine particles of sand, the excrement and other matter, adhering mostly to the outside, and only sufficient to give a faint greenish tinge to the whole, when moistened and comminuted. When submitted to great heat the small amount of organic matter is observable in the odor and a slight discoloration, but no ash is produced, and the sand crystals are visible with a good lens, and grate under pressure of a knife-blade. The case is, for these reasons, quite brittle, and easily resolved into a fine powder; and we can, with this knowledge, understand the philosophy of the ridges, which are evidently intended to give strength to the case, and not for mere fantasy or ornament.

The larva of this insect differs little from those of other case-bearing genera, such as *Chlamys*, *Clythra*, *Cryptocephalus* (Fig. 37, *Chlamys plicata*, Oliv.—after Packard): indeed, species and even genera are more easily distinguished, in this state, by the cases themselves than by the larvæ that dwell within them. It is of a yellowish-white color, with the head, a shield on the first joint, and the legs, brown-black (*f*, underside of head; *k*, jaws; *l*, maxillary palpus; *j*, leg enlarged); and as will be seen by the figure (*a*), with the posterior part of the body rather heavy and curled under, something as in a small, White Grub, or May-beetle larva. The anus is thus brought in close contact with the legs, and the excrement is passed by these to the mouth and ejected, and the case thus kept clear inside.

[Fig. 37.]

CHLAMYS PLICATA:—Larva, within and without its case.

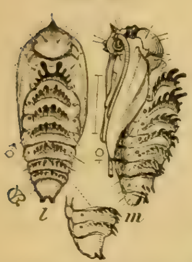
I have not yet succeeded in bringing the insect through all its transformations, but have kept it feeding for ten months from the egg, or from the 1st of June till into the following March; and judging from the fact that at the end of this time the larval growth was not more than half attained, it is probable that, as is known to be the case with some European Clythras, more than one year is required for its full development. From analogy we may, with sufficient certainty, infer that when full grown, it closes up the mouth of its case, turns around in it before becoming a pupa, and finally eats its way out as a beetle, not from the broad and sealed mouth, but through a lid cut at the small apical end originally surmounted with the egg-case. The larvæ of some European species of *Clythra* are known to climb onto plants

just before pupating, and to abandon their dry food for that which is more green and succulent.

As this insect has never been found in large numbers, and contents itself during most of its life with that which is valueless to us, it can not be considered as injurious; and I have introduced it to my readers rather on account of its curious life-history than because of the few sumach leaves which the beetle riddles.

THE YUCCA MOTH—*Pronuba yuccasella* Riley.

[Fig. 38.]



PRONUBA YUCCASELLA:—*l*, male; *m*, female chrysalis.

My observations of the past year have enabled me to complete the natural history of this curious and interesting insect. Regarding the chrysalis, I extract the following from the Transactions of the St. Louis Academy of Science (Vol. III., p. 178):

"As I suggested it would, the larva remains in its cocoon unchanged all through the fall, winter and spring months, and does not assume the chrysalis state till a fortnight or so before the blooming of the Yuccas. It is one of the hardiest larvæ I have had to do with, and will not only repeatedly mend its cocoon when this is cut or torn, but, when extracted from it, will survive for months if afterward kept in a tight vessel. This tenacity of life makes its safe transportation from one country to another all the more sure and easy.

"The chrysalis works its way through a long dorsal rent in the larval skin, so that this latter is not compressed into a little mass, as is the more usual way with Lepidoptera, but retains nearly its original length.

"DESCRIPTION OF CHRYSALIS, ♀ (Fig. 38, *m*, lateral view).—Average length 0.30 inch; greatest diameter about 3-7 the length. Thick and stout, with the dorsum greatly arched. Head with a prominent, conical projection on top, and two smaller ones between the eyes. Most characteristic feature a series of six dorsal, arcuated, horny plates—one on the anterior half of each of joints 5–10. These plates have anteriorly 10–12 blunt, flattened, recurved projections, the largest in the middle, from which the others are successively lessened. The ends of some of the larger ones are shaped like the share of the more common shovel-plow. In the first row the arcuation is greatest, and the projections largest and directed most forward; all which features are gradually lessened with each succeeding joint. Joint 11 has no plate, and but four posteriorly-directed spines, while joint 12 has two broad and flattened dorsal processes. Tip of abdomen rounded and reaching beyond the processes. Each joint has a transverse series of stiff yellow hairs, and four such are quite conspicuous on mesothorax, and others on top of head and on face. Color, when fresh, pale green, with the wing-sheaths darker. When mature, and just before giving forth the moth, the head, tho-

rax, breast between the antennæ, and tip of abdomen, are light brown; the eyes, dorsal plates and projections, darker brown; the wing-sheaths and interspaces between dorsal plates, whitish; and the sides greenish.

"♂ (Fig. 38, *l*, dorsal view) distinguished generally by his somewhat smaller size; by the dorsal projections not diminishing on joints 8–11, but rather increasing in size; by the greater shortness of joint 11, and greater length of joint 12; and by the apex not being so rounded, and not extending beyond the broad anal horny processes. At maturity the maxillary pieces are somewhat flatter, owing doubtless to the fact that in ♀ the spiny cylindrical tentacles lie stretched nearly their whole length, and cause them to bulge more.

"Thus in the chrysalis state this insect is as abnormal and as admirably adapted to its conditions and wants as it is in the larva and imago states. Sexual distinctions are very rarely observable in chrysalides; but after I had learned to distinguish between them I could readily separate the sexes in this case, and my judgment was confirmed upon the issuing of the moths. By a series of contortions, but more especially by alternate forward and backward movements of the dorsal projections, this chrysalis easily ascends to the surface of the ground, the cephalic spines serving to open the end of the cocoon, and the dorsal projections making excellent levers by which it pries its way through the soil.

"I found it very difficult to hasten the natural process of development, for notwithstanding that, in my anxiety to force a few specimens, I kept them throughout the winter in a mean temperature of about 80° F., I did not succeed in getting a chrysalis until May 5. As the blooming season of our filamentous Yuccas is comparatively brief, and as all moths issuing before or after such blooming would be likely to die without issue, we find the habit of developing at the proper season very strongly fixed. My first moths issued (three of them, all forced) May 30, leaving their exuviæ lying on the top of the ground. The cocoons out-doors, and which are seldom more than five or six inches below the surface of the ground, yet contain (June 2), many of them, the unchanged larva."

Regarding the method of oviposition, I copy the following communication to the *American Naturalist* (Vol. VII., Oct. 1873):

"To complete the natural history of *Pronuba yuccasella*, a description of the method of oviposition is necessary. In a former article [Rep. V., p. 155] on this insect, occur the following sentences:—

'For want of sufficient time, I have been unable to catch the moth in the act of oviposition; but from careful examination I am satisfied that the eggs are not deposited on the outside of the fruit. They are either thrust into it from the side or from the stigmatic opening, following, most probably, the course of the pollen tubes. I strongly incline to the latter view, for, though many Lepidoptera are furnished

with extensile ovipositors, which enable them to thrust their eggs into crevices and other orifices, I know of none which actually puncture, nor have I been able to discover any trace of punctures leading to eggs.

'Neither have I been able to discover the egg *in situ;* which is not to be wondered at, however, as when examined in the female abdomen it is found to be long, narrow, soft and flexible, and of the exact color of the flesh of the young fruit. The ovipositor is so very fine and extensile that it may be thrust into the most minute and narrow passage.'

"Analogy has proved an unreliable guide in this instance, as, indeed, it often does in natural science; while the curious ♀ *Pronuba* adds one more to the anomalies which belong to her. She *does puncture* the young fruit and convey her eggs into it from its side.

"The Yucca flowers are fully opened and perfect during a single evening and night only, and it is during this, the first night of blooming, that eggs are consigned to the somewhat prismatic pistil. The pollen grains are not so often expelled, to fall on the inside of the flower, as I had been led to suppose; but almost always remain in an entire lump on the contracted and curled anthers. The moth, consequently, has no difficulty in accumulating her little load of pollen, for a single anther furnishes nearly the requisite amount.

"Once equipped with this important commodity, she may be seen either crawling over or resting within the flower. From time to time she makes a sudden start, deftly runs around and among the stamens, and anon takes position with the body between and the legs straddling some two of them—her head turned toward the stigma. As the terminal halves of the stamens are always more or less recurved, she generally has to retreat between two of them until the tip of her abdomen can reach the pistil. As soon as a favorable point is reached—generally just below the middle—the lance-like sheath of the ovipositor, which consists of four converging, corneous bristles, is thrust into the soft tissue, held there a few seconds while the egg is conducted to its destination, and then withdrawn by a series of up and down movements. So intent is she upon this work that after the evipositor once penetrates the pistil the whole perigon may be detached, some of the encumbering petals and stamens removed, the insect brought within the focus of a good lens, and all her movements observed to the greatest advantage, without disturbing her. In this way I have been able to watch the consignment of hundreds of eggs, and to admire the delicacy and elasticity of the ovipositor proper, which issues from the setaceous sheath in a silk-like thread, almost invisible to the naked eye, and as long as the terminal abdominal joint; and which stretches and bends according as the body is raised or lowered.

"No sooner is the ovipositor withdrawn into the abdomen than the moth runs up to the top of the pistil, uncoils her pollen-bedecked tentacles, thrusts them into the stigmatic opening, and works her head vigorously as I have previously described—the motion being mostly up and down and lasting several seconds. This carrying of the pollen to the stigma generally follows every act of oviposition, so that where ten or a dozen eggs are consigned to a single pistil, the stigma will be so many times be-pollened. The ends of the tentacles, which are most setose and spiny, and which are always curled into the pollen-mass when not uncoiled, must necessarily carry a number of pollen grains each time pollination takes place; and I have noticed a gradual diminution in the size of the collected mass, corresponding, no doubt, to the work performed, which is indicated by the rubbed and worn appearance of the individual—the freshest specimens always having the largest loads.

"While oviposition is generally followed (and not preceded, as I formerly supposed) each time by pollination, yet the former sometimes takes place twice, thrice or oftener without the latter being performed; and I suspect that the converse of this is equally true.

"Although often marking the exact point at which the puncture was made, it is so very fine and the fruit tissue so soft and succulent, that I never succeeded in tracing the passage to the locus of the egg until I dipped the pistil in ink. If carefully done, without bruising the surface or allowing the ink to run in at the stigma, the fruit, by this operation, will be discolored only where the ink has followed the recent puncture, which may then be traced by means of a lens; though by extraordinary practice and manipulation it might doubtless be traced under the microscope, without such aid. The egg is very narrow and elongate, soft, flexile, rather translucent, pointed anteriorly, and of the exact color of its surrounding. It lies curved in the ovarian cavity, always on the rounded side next the primary dissepiments (in the cases I have noticed), and with the anterior end for the most part close to the placenta. These facts are best ascertained a day or two after the fruit is plucked, when, in the ink-dipped specimens, a sunken black cicatrice forms around the mouth of the puncture, and the ovarian cavity enlarges by the shrinking of the adjoining tissues. I have little doubt that the egg increases in bulk before hatching, under the influences of impregnation and endosmosis, and Dr. Engelmann tells me that he has been able to trace the embryo larva under the extremely delicate egg-covering, and to observe it curled up at the anterior end of the egg, which greatly enlarges. This larva hatches on the fourth or fifth day after the laying of the egg, and usually commences feeding between two ovules, which, in consequence of its

action, swell abnormally. Thus, in making a longitudinal section of the fruit, these swollen ovules often indicate the presence of the worm where it would otherwise be overlooked while very small.

"While oviposition generally takes place in the manner described, the moth head outward and straddling two stamens, an entirely opposite position must sometimes be assumed, since larvæ and punctures are not unfrequently found in the upper part of the fruit, especially where a single one is stocked with ten or a dozen larvæ, as is sometimes the case.* As the fruit enlarges, the mouth of the puncture forms a slight, discolored depression, more noticeable in some varieties than others; but the passage-way becomes obliterated.

"My observations this summer might be extended much in detail. They have convinced me more than ever that *Pronuba* is the only insect by the aid of which our Yuccas can be fully fertilized: for I have studied this fertilization diligently night after night, without seeing any other species go near the stigma. The stigmatic opening closes after the first night, and I know of no crepuscular or nocturnal species which could collect the requisite amount of pollen and bring it so to bear on the stigma that each ovule would receive the influence of a pollen grain. The species already eunmerated† as frequenting Yucca are mostly diurnal, and have nothing to do in the work; and wherever I have excluded the moth from the flowers, by enclosing the latter with netting, no fruit has been produced. I am, therefore, led to believe that the few rare instances of yucca-fertilization, in localities where *Pronuba* may be presumed not to occur, have been brought about by another insect accidentally, or by the stamens reaching an exceptional length, and the anthers being brought into contact with the stigma by the conniving of the closing petals. I have found the stamens of varying length in the flowers on the same panicle, and in some instances almost as long as the pistil."

* I have counted as many as twenty-one larvæ in a single capsule of what is apparently *Y. flaccida*.

† Rep. V, p. 151.

HACKBERRY BUTTERFLIES.

One of the most beautiful of European butterflies, much coveted and prized by the collector, especially in England, where it is extremely rare, is that known as the Purple Emperor (*Apatura Iris* Fabr). The wings in the male of this magnificent species exhibit now the deep brown which alone the female, as a rule, possesses, now a beautiful deep violet-blue, according to the direction from which we view them. This changeability of color is owing to the peculiar form, shape and arrangement of the wing-scales. If, by the aid of a good microscope, we examine these scales, we shall see that, besides the longitudinal imbrications so generally characteristic of the wing-coverings of the *Lepidoptera*, they are furnished, on the parts naturally exposed, with innumerable minute, transverse, angular ridges, each having a brown and each a blue surface exposed—a fact which, by means of his excellent magnifier, Rosel von Rösenhof demonstrated a century and a quarter ago, and which at once explains the peculiarity which renders the butterfly so conspicuous among its scaly-winged companions. The adolescent life of this butterfly is quite interesting, and there are amusing accounts of the zeal with which the larva and chrysalis have been sought by some of the earlier entomologists, and of the pleasure which their discovery has afforded. The larva feeds on *Salix*.

In this country there are two butterflies belonging to the genus *Apatura*, as heretofore understood: viz., *Lycaon* Fabr. and *Herse* Fabr. The complete natural history of these has so far remained untold; and from any figures or descriptions extant they could not be distinguished from each other in their earlier stages. In Boisduval et LeConte's *Iconographie*,* to which we naturally look for something respectable, the figures are, to speak in their own language, *affreuses*. No characteristics are given by which the larvæ could be separated with any certainty, while the chrysalides are wrongly represented hanging by the tip of the body, at right angles from the point of attachment (which they never do), rounded and entire dorsally (they are notched and angular), and without a single generic character that belongs to them. Nor authors nor draughtsmen, if they ever saw the

* *Hist. Gen. et Icon. des Lépid, et des Chenilles de l'Am. Sept.*, 1833.

earlier stages of these butterflies, could have looked at them with any degree of care; and it is quite natural that neither the descriptions in Morris's "Synopsis," which are abridged from the *Iconographie*, nor the figures in Glover's unpublished Plates, which are copied from the same, should gain in lucidity. Dr. Asa Fitch* makes a brief allusion to *Herse*, but the information he communicates is evidently obtained from the *Iconographie*, just mentioned, as it contains the same errors. None of our other standard entomological authors refer to these butterflies, for which reason a few facts regarding them may not be uninteresting.

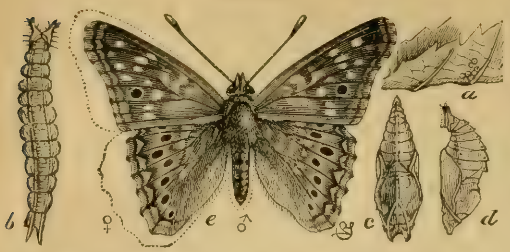
They both feed on Hackberry (*Celtis*), and, so far, I have found them on no other plant. The Hackberry is sufficiently common in the bottom lands of Missouri, and two tolerably constant forms are easily recognizable: 1—(*occidentalis* Linn.) with broad, roughish, sharply serrate leaves, purple-black drupes, and rather pale bark, which on the trunk is rough and strongly cleft so as to look as if hacked; 2—(*Mississippiensis* Bosc.) with smaller, narrower, darker leaves, less serrate and often entire, yellow drupes, and darker bark, the trunk appearing knotty. A third form (*crassifolia* Lam'k), having most the aspect of *Ulmus*, occurs less frequently. It is much like *occidentalis*, but with more supple limbs, and rougher, thicker leaves, which, when plucked, wilt much more rapidly than do those of the other forms. Botanists differ as to whether these forms are specific or varietal. Dr. Gray refers them all to *occidentalis*, and, as intermediate varieties are found and the seedlings from the same tree are exceedingly variable, this seems the proper course. But Prof. Planchon, who has monographed the genus, considers 1 and 2 good species, and the third doubtful. The two butterfly larvæ I am about to speak of feed indiscriminately on all three, but so far as my experience goes, show a preference for *occidentalis*.

THE EYED EMPEROR—*Apatura Lycaon* (Fabr.)

During the month of May the larvæ of this species may be found on the above-mentioned trees, coming to their full growth, pretty uniformly, by the end of the month. They are then (Fig. 39, *b*, and Fig.

* 3d N. Y. Rep., § 83.

[Fig. 39,]



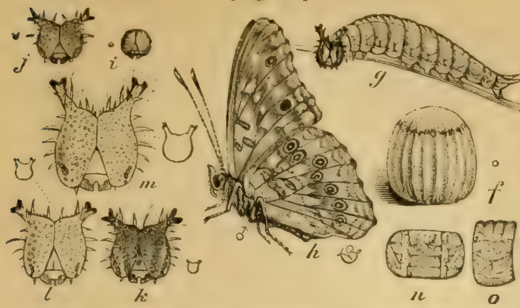
APATURA LYCAON:—*a*, egg; *b*, larva, dorsal view; *c*, *d*, chrysalis; dorsal and lateral views; *e*, imago, male, the dotted line showing form of female—all natural size.

40, *g*) rather more than an inch long, of a pea-green color, with a series of yellow spots along the middle of the back, and three yellow lines each side, the intermediate one undulating, often obsolete on the anterior part of each joint, and containing a little lead-colored dimple. The body is more or less thickly granulated with pale papillæ, reminding one of *Paphia* [2d Rep., Fig. 94; 5th, Fig. 12]; swells in the middle, from which it tapers both ways, the anal extremity ending in two horns. The back and sides are flattened, the latter sloping slightly, roof-fashion. The most characteristic feature is the head, which, though variable in color, is always surmounted at this age with two antlers.

This larva is found when at rest on the under side of the leaf, usually on a carpet of silk, and often with a portion of the leaf bent around it. The lower part of the head is then drawn under the neck and the antlers thrown forward (Fig. 39, *b*). In preparing for the chrysalis state, it spins on the under side of a leaf a little bunch of silk in which to entangle its anal prolegs. Sometimes, but not often, it partially covers itself with a curled leaf, or with two leaves drawn together. Here it rests for about two days, when the larval head and skin split open, and the soft and unformed chrysalis works them back to the extremity of its body. It then secures itself, knocks off the shrunken skin, and soon assumes the delicate green color, marked with cream-yellow, and the elegant form (Fig. 39, *c*, *d*), which Nature has imposed upon it. Most naked chrysalides, which have the bodies appressed to the object of attachment, are girded and supported by a loop adroitly constructed by the larvæ,* but our Lycaon chrysalis, by aid of its peculiarly elongate anal pad of crochets running under the end of the abdomen, is enabled to retain this position without any such loop. In this it differs from all the other members of its family (*Nymphalidæ*), which simply suspend themselves by the tail, and which hang more or less directly at right angles from the object of attachment, when not supported by leaves.

* This is well known to be the rule in the Rhopalocerous families *Papilionidæ*, *Erycinidæ*, and *Lycænidæ*. It occurs also in some Heterocerous genera. I have bred the neat little Geometrid *Acidalia persimilata* Grote from *Ageratum*, and its chrysalis mimics *Papilio* not only in being supported by a loop, but in having ocellar tubercles. The same habit obtains in the European Tineid *Elachista cinereopunctella* Haw., which mines the leaves of *Carex* (see Stainton's Nat. Hist. Tin. III., Pl. 4, Fig. 1, *c*), and doubtless in others.

[Fig. 40.]



Apatura Lycaon :—*f*, egg, magnified; *g*, larva, lateral view; *h*, imago, underside—natural size; *i*, *j*, *k*, *l*, *m*, the five different larval heads; *n*, *o*, dorsal and lateral views of larval joint—enlarged.

The chrysalis state lasts about ten days, when the enclosed butterfly bursts the fragile shell and drags its limp self out. Clinging for a time to the ruptured husk, while the compressed wings visibly enlarge, the butterfly at last flies off—a perfected piece of Nature's unrivaled handiwork. Well known in cabinets under the old name of *Apatura celtis* Boisd., it is of a more or less intense russety-gray, inclined to olivaceous, and shaded with dark brown, which, in certain lights, shows its relation to the European *Iris* by a faint purple reflection. The figures (39, *e*, and 40, *h*) will stand in place of more elaborate description. Aside from the genital organs, the sexes are, as a rule, quite easily distinguished by the larger size of the female, and her less falcate front wings and broader, more rounded hind wings; but where these characters can not be relied on, as is sometimes the case, the sexes can yet be distinguished by the difference in the impotent front legs, the male having the feet (*tarsi*) and shanks (*tibiæ*) of these legs covered with soft whitish hair, while in the female they are naked, as in the other legs.

The butterflies begin to appear in the latitude of St. Louis by the middle of June, and by the end of that month the eggs may be found. These eggs (Fig. 39, *a*, and 40, *f*) are attached rather slightly to the under side of a leaf, either singly or in small clusters not exceeding a dozen. In form they are nearly globular, with very delicate longitudinal ribs, and still finer transverse striæ. In hatching, the enclosed larva pushes open the crown, which lifts like a cap. When first hatched this larva is of a uniform yellow, sparsely covered with a few soft hairs, and with a head (Fig. 40, *i*) which is jet-black and always hornless—thus differing materially from the head subsequently worn. The larvæ of this, the first, brood feed for rather less than a month, when they transform and give out the second brood of butterflies during August. These lay eggs again, which in due time hatch. But the second brood of larvæ thus hatching, instead of feeding with good appetite as did the first brood, is more lethargic from the start, and develops more slowly. Every worm, after passing through the second or third molt, ceases to eat; then shrinks in size and stations itself on the under side of a leaf. Here it changes its fresh green color for a dingy, grayish-brown, (caused by more or less distinct purplish marks

on a dingy yellow ground), the better to keep in conformity with that of its dying support, with which, eventually, it falls to the earth, and there hibernates. A heavy snow may cover it many inches deep; a drenching rain may soak it through and through; the mercury may sink 22° F. below, or rise 80° above zero; but this little worm is indifferent to all, and sleeps a profound torpid sleep from the first of October until vegetation starts anew the ensuing spring. The weather in St. Louis is often delightfully mild and even warm long after this larva has gone into winter quarters, but nothing short of the animating breath of the vernal year prompts it to renew the activity it lost the fall before.

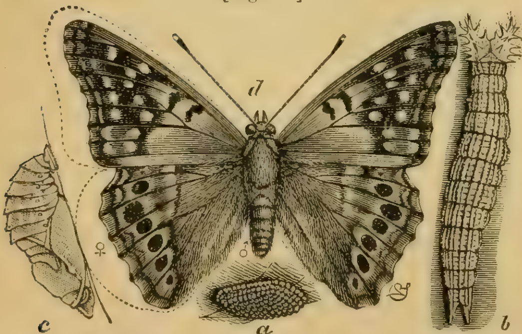
In acquiring its winter habit the joints are greatly contracted, the body becomes somewhat translucent, while the hairs from the papillæ become stouter; and in this condition it has a conchiliform appearance, and strongly recalls the young *Thecla* larva, or the young larvæ of such Heterocerous genera as *Euclea* and *Adoneta*.

Thus there are two broods each year, but they overlap each other so that a few of the later individuals of the first coëxist with the earlier individuals of the second, and the butterflies may be found more or less abundantly from early June till September.

The larva experiences four molts, so that there are four heads (*i*, *j*, *k*, *l*) which are shed entire, and a fifth (*m*) which is split open by the chrysalis and attached to the last larval skin. During the rest preceding each molt the antlers of the new head will be found laid back on the first joint, below the skin.

THE TAWNY EMPEROR.—*Apatura Herse* (Fabr.)

[Fig. 41.]

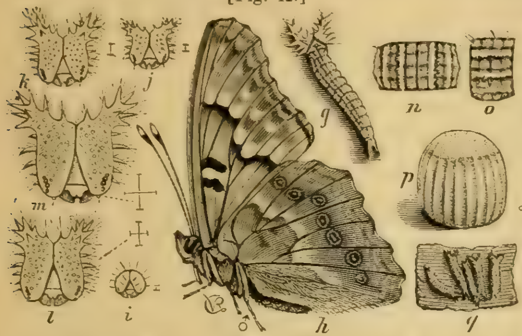


APATURA HERSE:—*a*, eggs; *b*, larva; *c*, chrysalis; *d*, imago, male, the dotted line showing form of female—all natural size.

This butterfly (Figs. 41, *d*, and 42, *h*) is at once distinguished from *Lycaon* by its larger average size, more fulvous color and different ornamentation, especially of the front wings. Aside from the sexual characters already given in speaking of the previous species, the male in *Herse* is generally brighter colored than the female, with the markings, especially of hind wings, much more clearly defined; so that, instead of the distinct

pattern of hind wing which I have illustrated (Fig. 42, *h*), the female has the marks more or less obsolete, and the general tint deeper and more uniform. The species extends farther north and east than *Lycaon;* but in the Mississippi Valley and the more southern States, both species occur, and I have often found their larvæ feeding on the same tree. *Herse* is, however, less common than *Lycaon.* Boisduval gives *Prunus* as food-plant of the species, but it has never been since recorded as occurring on trees of that genus, and Mr. Samuel H. Scudder, of Plymouth, N. H., to whom I sent young larvæ, found they refused plum-leaves, and died rather than eat of them.

[Fig. 42.]



APATURA HERSE:—*g*, larva, half grown, dorsal view; *h*, imago, male, under side—natural size; *i*, *j*, *k*, *l*, *m*, the five different heads of larva; *n*, *o*, dorsal and lateral views of larval joint; *p*, egg—enlarged; *q*, larvæ as when hibernating—nat. size.

The eggs of *Herse* (Figs. 41, *a*, and 42, *p*), unlike those of its lesser congener, are invariably deposited in dense batches of from 300 to 500, and two, or more often three, tiers deep. Otherwise they differ from those of *Lycaon* mainly in being a little broader on the crown. When first laid they are pale yellowish-white, but toward hatching, the mass, if uninjured, acquires a deeper buff color. The larva, in the first stage, is easily distinguished by its copal-yellow, instead of black, head; and in the other stages by having a dark medio-dorsal line, and a straight, instead of a wavy, supra-stigmatal line. The head is also larger, more pubescent, broader at top, and with the antlers larger, more spiny, and more hairy. The spines vary somewhat in sharpness and size, but are often very conspicuous in the third molt, when a worm at rest presents a really singular appearance (Fig. 42, *g*). These larvæ are more or less gregarious up to the third molt, after which they scatter. The habit, after they scatter, of hiding within leaves drawn around them, is more determined than in *Lycaon*; and the young of the second brood fall with the leaf, and hibernate huddled together in companies of five and upward (Fig. 42, *q*). They have a habit, before separating, of feeding side by side, eating the leaf from the tip downward, but leaving the stouter ribs. Spinning a thread wherever they go, they often, in traveling from leaf to leaf, make quite a pathway of silk; and if the branch be suddenly jarred, they will drop and hang suspended in mid-air, and, after reassurance, climb up again with the thoracic legs.

I have not reared this species from the egg to the imago as I have the smaller species, but it doubtless goes through the same number of molts, as I possess five different sized heads. It is probable, however, that the number will not correspond in the æstival and autumnal broods; for I have reason to believe that some of my first brood of *Lycaon* larvæ went through but three molts; while I have watched *Herse* go through the third molt after it had ceased feeding in the fall, with scarcely any perceptible enlargement of the head—this third head being of smaller size and browner color than the corresponding one from the first brood.

Both species are found on the lower branches of the trees more especially, and very seldom on the higher.

PARASITES.

The Tawny Emperor is evidently most prolific, and one would suppose that it would be the most numerous; but its eggs, being laid in a batch, are more apt to be destroyed in great numbers by cannibal and parasitic insects. Such, indeed, is actually the case; for, while I have yet found no parasites on *Lycaon*, of ten batches of *Herse* eggs eight have been found more or less infested with a minute Chalcid-fly, one fly to each egg.

The egg thus infested becomes purplish, so as readily to be distinguished from the sound ones, and even when empty, an egg that has been parasitized is easily recognized by the crown being perforated instead of lifted up. I have not reared the parasite, and have been unable to extricate any perfect specimens. From fragments, the species seems to be blue-black; what appear to be the front tibiæ have a prominent spur lacking in the others, while the antennæ seem to be 6-jointed, 2 being twice as long as bulbus, 3, 4 and 5 subequal and half as long, 6 fusiform and as long as 2. It evidently belongs to the *Trichogrammidæ*, and comes near *Brachista*.

BIBLIOGRAPHICAL.

For forty years past these two butterflies have been known in entomological works by the names of *Apatura celtis* Boisd. and *A. Clyton* Boisd. Even in Mr. Edwards's recent work* these familiar names were retained. But in Mr. Scudder's Revision† these insects are referred to under the generic name *Doxocopa*, and the specific names which I have here employed.

Of the generic name it need only be said that *Apatura* was created by Fabricius in 1807; *Doxocopa* by Hübner in 1816. From information kindly communicated by Mr. Scudder, the latter genus

* The Butterflies of N. A., by Wm. H. Edwards, Philad., 1868-72.

† Sys. Rev. of Some of the Am. Butterflies, by S. H. Scudder; Salem Mass., 1872.

seems to differ from the former principally in the antennæ being proportionally more slender, the club shorter and less uniform, the palpi more slender and yet shorter, and the legs also more slender; while the hind wings in the male *Apatura* are not hollowed out as in *Doxocopa.* This last character is of little value, as it is variable in the same species. The other points of difference also appear trivial indeed when we consider the many points of resemblance. It is reasonable to suppose that many of the honored writers on diurnal Lepidoptera, since Hübner's time, have been familiar with his diagnosis of *Doxocopa*, and they ignored the genus because they considered that the characters were not sufficient to separate it from *Apatura.* Kirby, as late as 1871, did so. Opinions will differ as to what should constitute a genus, and my own opinion is expressed in the name I here employ. Mr. Scudder may be able by study of the preparatory stages to establish more emphatic differences in his forthcoming work. If so, *Doxocopa* will doubtless be employed for our species, but it will be *Doxocopa* Scudder and not *Doxocopa* Hübner, as the latter knew nothing about those differences. Until that time I have thought best to follow preceding authors. Judging from figures of the European *Apaturas*, the most important differences between them and our two N. A. species will be found in the chrysalis state, and principally in the shape of the cremaster. The horns of the European larvæ are less branching, and the notum of the throax in the chrysalis is more depressed; but our two N. A. species also differ in these characters.

Regarding the specific names, *Lycaon* and *Herse* were named by Fabricius, as Mr. Scudder informs me, from paintings, "unquestionably representing our species, in the possession of a Mr. Jones," and now at Oxford, Eng. No locality was given for them. Did some rule prevail such as that which has been suggested by Professor Westwood—viz., that after an insect has been universally designated, say for a quarter of a century, by a specific name, that name should nevermore give way to any that might be resuscitated—we should not now be called upon to change Boisduval's familiar titles for these familiar butterflies. So long as no such rule exists, the quickest way to get rid of the confusion now attaching to the specific nomenclature* is to follow Mr. Scudder, who has given the subject so much attention. In the higher animals, Audubon and Bachman did not hesitate to reject such names as *Anisonyx rufa* Rafinesque, or *Arctomys rufa* Harlan—names given to an animal which Lewis and Clark had described, but which the namers had never seen; and to adopt, instead, the *Aplo-*

* For instance, *Lycaon* and *Herse* are referred by Kirby (Syn. Cat. p. 87) to *Hipparchia*? and yet on p. 262 of the same work we have *Aptura Lycaon*, of which *Herse* is designated as ♀.

dontia leporina Richardson, which, though it had not priority, was first coupled with a truly recognizable description from the animal itself. On similar grounds Mr. Scudder would have been justified in rejecting the Fabrician names. As a matter of interest to Lepidopterists, I produce these two descriptions (kindly copied for me by Mr. Scudder) which have remained so long unnoticed and unrecognized:

[FABRICIUS, *Entomologia Systematica*, Tom. iii., pars 1, p. 228.]

Lycaon, 714.—P. S. Alis dentatis, anticis fuscis, flavo alboque maculatis, posticis ferrugineis, ocellis sex cæcis; subtus variegatis, ocellis octo.

Papilio Lycaon. Jon. fig. pict. 4, tab. 17, fig. 1.

Habitat ———, Mus. Dom. Drury.

Corpus medium, fuscum abdomnis lateribus fulvis. Alæ anticæ supra fuscæ; flavo alboque maculatæ ocelloque cæco atro iride rufa; subtus basi flavæ, fusco maculatæ, apice fuscæ maculis tribus albis ocellisque duobus atris iride flava, anteriori pupila alba, posteriori cæco. Striga marginalis flava. Posticæ basi obscuræ striga e maculis quinque flavis, apice rufis, maculis sex ocellaribus, atris. Subtus flavo fuscoque variegatæ, ocellis, octo atris, iride flava pupillaque cœrulea [p. 229.]

Herse, 718. P. S. Alis dentatis fusco ferrugineis: anticis albopunctatis, posticis utrinque ocellis, septem cæcis. [p. 230.]

Papilio Herse. Jon. fig. pict. 4, tab. 7, fig. 2.

Habitat ———, Dom. Drury.

Corpus fusco ferrugineum. Alæ anticæ obscure ferrugineæ, pone medium fascia e maculis sex punctisque quatuor apicis albis, subtus pallidiores. Posticæ fusco ferrugineæ ocellis septemnigris iride ferruginea: secundo tertioque pupilla ferruginea, reliquis cæcis. Subtus pallidiores ocellis septem cœruleis iride flava, annulo nigro.

It will be seen that, aside from minor shortcomings, the difference in average size between the two species is not stated; nothing is said of the under side of the bodies; no sexual distinctions are given; while the description of the spots on the primaries of *Herse* as white is well calculated to mislead, for in all specimens which I have seen they are distinctly bright ferruginous or "ochry-yellow," as Boisduval describes them. The figure from which the description was made, if it represents our species, must be incorrect, or must have been made from an etiolated specimen. As to the number of the spots, it varies on the primaries; and on the secondaries, while in both species the seven ocellar spots are always distinct inferiorly, the first and last are often, one or both, partly or entirely obsolete superiorly, so as to leave but five or six. More generally six are visible in the ♂ and five only in the ♀. The eighth inferior spot in *Lycaon*, as described by Fabricius, can only refer to the small, more or less obsolete, and almost always simple, oval spot on the middle of the inner border.

It is doubtful if, without the drawings, these Fabrician species could have been satisfactorily determined; so that Boisduval can not be blamed for redescribing them. We should be justified in ignoring

such inadequate descriptions in a modern author; but, for many good reasons, it is the custom to make the best of those of the older author, who sometimes described a species in one single word.

HAVE WE OTHER SPECIES OF THE GENUS IN THE UNITED STATES?

Besides the two species of *Apatura*, the natural history of which I have just detailed, three other supposed species have been described, viz., *A. Idyja* Hübn (*Doxocopa I.*, Exot. Schm.), *A. Proserpina* Scudd. (Trans. Chic. Ac. Sc. I., p. 332), and *A. Alicia* Edw. (Butt. of N. A., p. 135). I know nothing of the first; but from the fact that Kirby (Syn. Cat. Diurnal Lep. p. 262) considers *Clyton* Boisd. a synonym, it will, perhaps, turn out a variety of *Herse* Fabr. The other two are considered synonyms—*Proserpina* of *Herse* and *Alicia* of *Lycaon*—by Scudder in his latest published opinion (Syst. Rev. etc., p. 9); and from the descriptions, I should agree with him in believing them mere varieties of the Fabrician species. It is, therefore, probable that we have but the two species I have figured.

Mr. Edwards informs me that he still considers *Alicia* a good species; and that he is confirmed in the belief from the fact that not a single *Alicia* was obtained from many specimens of *Lycaon* bred by himself last summer, or from those bred by me. But I should not expect to breed *Alicia* far away from its locality, any more than I should expect to breed the dark form of *Limenitis Misippus* or the dark female of *Papilio Turnus* in the more northern States. I am always suspicious of species founded on slight variations when one or two individuals only have been seen. *Herse* varies considerably, so that specimens as distinctly marked as my figure are the exception, and in the female the markings on the hind wings, both above and beneath, are often sufficiently obsolete to give the wing a uniform appearance, with the barest indication of a series of paler spots. *Lycaon* varies also not only in the intensity of color and distinctness of the marks, but in the relative size of many of the spots; that nearest the apex and that nearest the middle of the front wing being sometimes obsolete, while the dark ocellar spot on the same wing, which is usually simple, sometimes has a white discal speck. Mr. Edwards's *Alicia*, as may readily be seen from his excellent figures, is, so far as we now know, larger than the average size of *Lycaon*, and the general color is more fulvous; but there is absolute similarity of pattern between the two. Now as *Lycaon* varies both in size and depth of color, we may reasonably infer that *Alicia* will be found to do so, and that, so far as these characters go, the description of *Alicia* is from two specimens, and is of little value. The average size of *Lycaon*, in the locality from which I write, is much less than that of

Herse; yet Boisduval (*auctore* Morris) gives his *celtis* the same size and form as his *Clyton*, while Fabricius mentions no difference in the size of his two species; so that if we really have to do with three instead of two species, then *Alicia* Edw., so far as size is concerned, is but a redescription of *celtis* Boisd., and the small form which occurs in the Middle and Western States remains undescribed. The fact that Boisduval cites his *celtis* from the Southern States, and that his description of the larva does not at all correspond with mine, would indeed give such a view a degree of plausibility; but, for my own part, I much prefer to believe that the differences in the butterflies are varietal, and that the discrepancies between the descriptions of the larva may be accounted for on the strong probability that Boisduval's description and figure of the larva are as untruthful as those of the chrysalis. But all such questions must be left to the future to decide; meanwhile Mr. Edwards's opinion is, in one sense, as rightfully held as Mr. Scudder's or mine.

DESCRIPTIVE.

APATURA LYCAON—*Egg.*—Average diameter 0.03 inch. When first laid, opaque white, becoming day by day more translucent. About and around the crown are a few pale purplish specks and marks, which deepen until they are sometimes black, and as the embryo develops, its black head shows plainly through the crown and the egg becomes slightly grayer. Shape globular, the top flattened, the base still more so; about as wide as deep, averaging 0.025 inch either way, the depth most often exceeding. From 19-20 longitudinal, rather prominent ribs, and about twice as many very delicate transverse striæ, the latter best seen on the empty shell, and both ribs and striæ becoming obsolete on the crown.

Attached not very firmly and always on the under side of a leaf, in batches of from 1-12 (7, 7, 5, 7, 7, 1, 4, 2, 3, 7, 11, 12, observed). Egg period from 6-10 days.

Larva—Newly hatched 0.07-0.08 inch long. Body cylindrical, tapering very slightly behind, pale yellow, immaculate, with concolorous piliferous dots giving rise to short pale hairs, 4 of these dots dorsally trapezoidal and 3 lateral around each spiracle. Head twice as large as joint 1, polished black, slightly bi-lobed, with very minute pilose points and a few long hairs, but no horns whatever. Anal horns pale just after hatching, becoming dusky at tips, short, and terminating usually in three blunt, pilose lobes. When two days old, the dorsum flattens and the characteristics of the second stage begin to show. In the *second stage* the color is green, the form less cylindrical, each joint with four tolerably distinct annulets and numerous pilose papillæ. A straight subdorsal, longitudinal, yellow stripe connects across dorsum on anterior annulet, and sometimes on second, leaving, in consequence, a series of subquadrate dark-green dorsal spaces; a supra-stigmatal, undulate, paler and narrower line, and a substigmatal one straight and of the same thickness. Anal horns less blunt at tip. Head broader than long, with the sides bulging and with two horns on top diverging at right angles from each other, and in length about one-third the width of head, each ending in a prominent, more or less acute bifurcation, and giving out three lesser branches from the sides: also with a prominent lateral, slightly decurved and acute spine, a lesser one above and below this, and two on top between the bifurcate horns. The

color is quite variable, sometimes being entirely dark-brown, but more often pale, with the jaws, sutures, ground of ocelli, and tips of horns dark. It is furnished with a few short hairs. In the *third stage* there is but little change; joints 5–9 are proportionally somewhat more enlarged, and the spines on the head proportionally increased in length. The papillæ become more prominent and numerous, and the transverse yellow line connecting the subdorsal lines across the anterior wrinkles, as well as the supra-stigmatal line, becomes less continuous. The *fourth* and *fifth stages* are similar: the horns on the head are lengthened, but the forks and the spines shortened, while the transverse stripes and the supra-stigmatal line are generally interrupted. The mature larva may be thus described:

Average length, 1.15 inches. Head as broad or broader than long, the cheeks bulging, the horns half as long as head, slender, the bifurcations reduced and rounded, the spines not prominent; shallowly punctate and sparsely pubescent; color either green with faint touch of brown on jaws, at ocelli and tips of horns, or brown-black with more or less pale color, and always four stripes in front, two short ones near ocelli, and two others running by the side of epistoma and tapering up the horns. Body bright pea-green, very small on joint 1, enlarging in middle, and tapering to extremity, which ends in two horizontal, slightly diverging anal horns. Each joint with about four annulets. A medio-dorsal series of yellow spots the width of first annulet; a pale white and yellow stripe, thickest at sutures, running each side of dorsum to tip of anal horns; a series of pale, oblique supra-stigmatal marks containing a lead-colored impressed point; and a straight sub-stigmatal line. Covered with numerous irregular papillæ, largest on yellow parts. Ventrally more smooth, glaucous, and with soft colorless hairs. Legs pale, the pads of prolegs dusky. The supra-stigmatal oblique dashes are sometimes connected to form a wavy line, and there are other minor variations of color and markings.

Chrysalis—General surface faintly aciculate. Dorsum narrow-edged, in outline strongly arched on abdominal joints 3–8 (6–11 of body exclusive of head); straight and falling at an angle of about 130° from 3rd abdominal joint to metathorax, thence rising at the same angle straight to middle of mesothorax, and falling again at an angle of about 120° direct to head. From a dorsal view the outline broadens regularly from anal extremity to wing-sheaths, is parallel thence to the region of the metathorax, then bulges, and is broadest at the wing-shoulders, and gradually decreases again to the ocellar tubercles. The inferior surface forms a straight line from the eyes to the tip of the legs, then makes a slight upward curve and ends in a button or cremaster, which represents the anal larval prolegs, and is on a plane with the longitudinal axis of the body; it is divided anteriorly, produced into a trigonate blunt point behind, and furnished along the flat inferior surface with soft ferruginous hooklets, which issue from it at right angles and form a long, narrow pad, united and most dense at posterior extremity, but divided anteriorly. The ocellar tubercles are trigonate, the sides of the abdomen slope skiff-like, joints 6, 7 and 8 admitting of very free-side motion by broad, smooth sutures, which narrow dorsally to a point. The dorsal edge is slightly carinate, especially on mesothorax, and more or less jagged, especially on abdominal joints 3–8, which have their anterior edges produced into small teeth, like saw-teeth, white, with a polished black spot each side. A raised line starts from anterior edge of abdominal joint 3 and thickens to wing-shoulders; another, from middle of mesothorax, extends around outer edges of ocellar tubercles, while another margins the hind wings. The color is pale translucent green, with still paler and darker mottlings; a series of pale oblique lines and a longitudinal sub-stigmatal one on the abdomen. The dorsal carina is yellow on the arched abdominal portion, except at anterior edges of joints already

described; elsewhere it is cream-colored. The veins of wing-sheaths, joints of antennæ, and the raised lines, are all of the same pale color. Stigmata pale and barely noticeable.

APATURA HERSE. To avoid repetition it will be best to describe *Herse* by comparison with *Lycaon.*

Egg—On an average rather flatter on the top, with the sides more parallel. Pale yellowish-white at first, with the marks that afterward appear around crown fewer, and never as dark as in *Lycaon.* Attached to the underside of a leaf in batches of 300–500, generally three tiers deep.

Larva—When newly hatched differs from *Lycaon* in the head being pale copal-yellow and translucent; the jaws are brown, and ocelli spots black; the anal horns are scarcely perceptible; the pale hairs from piliferous spots are nearly as long as the diameter of the body. Before the first molt takes place the characteristics of second stage begin to show. In the *second stage* it is easily distinguished from *Lycaon* by being longitudinally striped superiorly with 8 pale and 7 dark stripes, or, in other words, instead of the subdorsal pale stripes connecting transversely on the anterior annulets, there is a medio-dorsal dark, continuous line, bordered each side with a pale one, and the supra-stigmatal line is straight instead of wavy. The head has stouter lateral spines and is more pilose. It is yellowish, and often with brown marks in front of the horns and around the mouth. In the *third stage* the colors are yet more intense, and the antlers lengthen, and, compared with *Lycaon,* the base of these antlers is stouter, so as to give a straighter appearance to the sides of the head, which are more stoutly spined and thickly pilose. In the succeeding changes these characters are little altered, except that the head becomes greener, the papillæ more conspicuous, and the medio-dorsal dark stripe proportionally narrower. The mature larva may be thus described:

Length 1.25–1.50 inches. Head bluish glassy-green, longer than broad, the sides almost parallel; with dark ocelli-ground and, rarely, dark marks in front and at base of antlers; shallowly punctate and quite pilose; the antlers stout, with lateral prongs as stout as terminal. Color of body usually bright green, the dorsum paler or yellowish, with a deep blue medial vascular line bordered each side by a paler yellow one. A subdorsal, supra- and sub-stigmatal continuous straight line, each either white or cream-color, and the two former either simple or bordered above with green and below with blue-green; the papillæ quite prominent on the subdorsal and substigmatal lines.

Chrysalis—Differs only in being larger, in showing on the abdomen traces of the pale longitudinal larval lines, and in having the mesonotal ridge less angular.

[The foregoing paper was published in the Transactions of the St. Louis Academy of Science (Vol. III, p. 193–208), and I have reproduced it without essential change, except in the common names used, which I have changed from "Lycaon Butterfly" to "Eyed Emperor," and from "Herse Butterfly" to "Tawny Emperor."* Since the first publication of the paper, Prof. Westwood, of Oxford, Eng., has been kind enough to send me copies of Mr. Jones's drawings, from which

* Popular names are just as desirable for our better-known insects, as for our more common plants or larger animals. They have, indeed, one advantage over the scientific names in that they do not fluctuate with every change in classification. But to be of real value, the popular name once given to an insect should be as much respected by subsequent authors as the scientific name first given. In no other way can we attain any stability or uniformity in such names. In writing of insects treated of by Harris and Fitch, I have used the common names employed by these authors, unless there was very good reason for not doing so; and it is to be hoped that American and Canadian writers on popular entomology will, by more care in this matter, help to establish names once used. I am glad to see that Mr. Scudder urges the importance of these common names for our butterflies, in the first number of "Psyche," a little entomological periodical which has just made its appearance in Cambridge, Mass., edited by B. P.

the Fabrician descriptions were made, and after a critical examination of them I have little doubt that Mr. Scudder is right in supposing them to represent the two butterflies herewith treated of.

Of *Lycaon* there can be no doubt whatever that it is *celtis* Boisd. In size the figures exactly agree with one of my specimens, captured by Mr. O. S. Westcott in Indiana (expanse 2.30 inches); i. e., they more nearly resemble, in this respect, the *Alicia* form than the average western form. The eighth inferior spot on the secondaries which Fabricius describes, and which I supposed (ante p. 144) must refer to the simple oval spot on the middle of the inner border, in reality refers to an eighth ocellar spot. The seventh of these spots in the insect is more or less double, in the sense of having a small, pupil-less spot confluent with it below. In Mr. Jones's figure it is more decidedly double, which will account for Fabricius's description.

With regard to *Herse* there is more room for doubt, for aside from the discrepancies in the description, which I have already indicated, as to the color of the spots on primaries, the fascia of six spots, in the drawing, runs, with but a slight and uniform curve, across the middle of the wing, instead of forming, as in nature, a sinuous line outside the middle of the wing; then again, in the drawing, these spots are oval instead of angular, and not relieved with black basally, as they are in nature. The pupil of the second and third ocellar spots of secondaries, as described, are wanting in all my specimens of *Herse*. I also note that while but four apical, or, more properly speaking, posterior spots occur on the primaries, according to the description, the figure correctly represents five, as in nature; and again, seven ocellar spots are described on the secondaries, whereas but six are represented in the drawing. But, allowing short-comings in the drawings, and others in the description, there are so many characters that belong to no other butterfly, that I have myself no doubt of the correctness of Mr. Scudder's conclusions; and *Herse* can not be the ♀ of *Lycaon*, as Mr. A. G. Butler has lately insisted, both by letter to me and by statement before the London Entomological Society, because, besides differing in color and other respects, it entirely lacks the large and characteristic black ocellar spot on the primaries. Westwood writes: "Not liking to judge of figures of Lepidoptera when not colored, I do not feel able to speak on the question of *Apatura Lycaon* and *Herse*; I think, however, that you are right."

Mann. Where an insect is better known in the larva than in the perfect state, it often becomes necessary to christen the former. But this does not preclude a second name for the latter; and in either case the study should be to express, as far as possible, in the shortest manner, some peculiarity in the appearance or habit of the species. There can be no sense in calling *Nematus ventricosus* the "Imported Gooseberry-worm," after it had been christened and much written of as the "Imported Currant-worm;" or in calling a Coccinella the "Aphis-eating lady-bug," when the Aphis-eating habit belongs to the genus, and the term "lady-bird" has long been the familiar and common designation of the different species. In the case of our two Apaturas, finding that Mr. Scudder contemplates following the English use of the term "Emperor," I have christened them accordingly, omitting the food-plant for brevity's sake.

I find nothing, therefore, to cause me to change the conclusions expressed in the paper, viz.: that we have but the two species of *Apatura*—*Lycaon* Fabr.=*celtis* Boisd.=*Alicia* Edw.; and *Herse* Fabr.=*Clyton* Boisd.=*Proserpina* Scudd.

Yet there will ever hang a certain doubt around *Herse*, and, for my own part, had I the above paper to write over again, I should steer clear of all doubt by using Boisduval's names, because I believe that the science is better advanced by the use of long-accepted names, drawn from the Creator's own pictures of the living animals, and having an undisputed and definite meaning, than by the unearthing of such as are drawn from man's pencil (and often faulty) imitations, and which admit of doubt and dispute. In other words, the "law of priority" becomes a nuisance and a positive injury to the science, when pushed to the unnecessary extreme of attempting to solve inexplicable riddles, or prying for truth where there is no more possibility of finding it than there was for Tantalus to slake his thirst or appease his hunger, or for Diogenes, with his lantern, to discover an honest man !]

KATYDIDS.

(Ord. ORTHOPTERA; Fam. LOCUSTIDÆ).*

I love to hear thine earnest voice
 Wherever thou art hid,
Thou testy little dogmatist,
 Thou pretty Katydid.
O. W. Holmes.

The worshiper at Nature's shrine in this country must miss, in part, the transport which the European may experience as he goes forth at morn in all the freshness and mildness of spring, to view our Mother Earth decked in her brightest and most pleasing garments. There—when fair Aurora, shattering night's dusky bonds, adds to im-

* These insects belong to the *Gryllidæ* of Westwood and the English school, and of our own Harris, the *Locustaria* of the French and German schools, and the *Locustariæ* of Scudder and Packard. They ought, I think, to form a subfamily of *Locustidæ* which may be called *Phyllopterinæ*. I use the family termination *idæ*, adopted by Mr. Cyrus Thomas (Hayden's Geol. Survey of the U. S., 1871), because I think that few things are more useful or important in Zoölogical nomenclature than uniformity in terminology for the different divisions.

brued field and wood a golden glory—to sally forth and listen to the delicious twittering of the sky-lark, as the love-prompted strain gradually dies away with the rising of the little songster over head, "to the last point of vision and beyond," is a pleasure we can hardly experience in this central portion of the rich Valley of the great "Father of Waters." Spring, with us, is apt to be but a narrow leap from winter to summer, while the dread of malaria too often outweighs what other inducements to an early stroll, our more chilly and heavily-dewed mornings may possess. Nor will the bright colors of our birds and flowers fully compensate for the enchanting song and sweet fragrance of those which add to the sylvan attractions of the more southern portions of England and the Continent of Europe. Our summer's intenser rays distill and draw away, through the limbec of our tree-clad hills, much of the inspiring incense which dwells in folded leaf and dewy cup about the forest there; while our wood-ticks, "jiggers," mosquitos and other tormenters, do not help the comparison in respect of personal comfort. Neither can we sit in prolonged twilight and listen to the rich volubility of the nightingale—that best of concerters: our twilight's but a word; we lack the mocking-bird, and fain must make the most of Whip-poor-will. But in autumn, when the leaves are turned by the interpenetrating and all-pervading touch of the Great Artist, who paints without brush, the American may read and enjoy the Book of Nature to most advantage, and need envy no one on any other part of our terraqueous globe. Then are the solar rays tempered by a dreamy, cloudless atmosphere all his own, for "a gauzy nebula films the pensive sky," and wakes the emotion expressed in Tennyson's precious lines:

> Tears, idle tears, I know not what they mean—
> Tears from the depth of some divine despair
> Rise in the heart and gather to the eyes,
> In looking on the happy autumn fields,
> And thinking on the days that are no more.

Then do grass and wood resound with song—not so much of feathered tribes as of insect tribes, and especially of the Katydids, green vaulters from leaf to leaf and from branch to branch — essentially American. The song of these entomological choristers may not compare in melody with that of the ornithological warblers; but though it grate at times, it has a merriness all its own, and, as it comes from bough or spear, can never be unpleasant, for there is no sadness in the earth's minstrelsy.

Some persons are easier wooed to sleep by the dull rumbling of a city's streets than by the autumnal voices of the woods; while others,

from inferior auditory endowment,* are deaf to much of the high-note music in the air.

But my readers are mostly of a class who often feel, with Cowper, that "God made the country and man made the town," and if, perchance, they must endure the city clash and clatter, they greatly miss the accustomed insect-medley which is so invariable an accompaniment of the ripening year. They prefer,

Rather the varied warbler song,
Or the loud shrill of insect wing,
Than sound of bustling city throng
With throttle's shrieking, deafening din.

And while breathing the oppressive air of a mid-summer noon, when all life is hushed into a pall-like stillness by the sun's fierce, enervating rays; or when Nature is shrouded and muffled in her mid-winter cloak of snow and ice, and all is voiceless and desolate; the ruralist must often wish for the merry notes of the lively little fiddlers which make up his autumn evening orchestra. Let us then scrape a more intimate acqaintance with the leading members of the troupe.

Since insects breathe through spiracles and not through their mouths, their mouths are everlastingly dumb. Yet there is not one of their numerous species but has a language of its own—a language frequently of signs and tokens, but often, too, of sounds; and an interesting chapter might be written on the various contrivances and different parts of the body employed by different species to make these sounds, as well as upon the sounds themselves. But not to digress, I shall come at once to our fiddlers. Blending with the ever-welcome croaking of the frog—that surest harbinger of spring—the first insect note we hear is the shrill chirrup of an occasional cricket (*Gryllus niger*). A few of these black little burrowers in the ground, manage to live through the winter in the perfect winged state, which accounts for their early playing, for none of the Crickets or Grasshoppers or genuine Locusts can perform without their wings, as on these are stretched the chords over which the bow is drawn. These insects are, therefore, true fiddlers, and they plied their vocation ages before Ole Bull was known to fame. Aye, long even before birds had been fashioned to pour forth their vocal melody, there is good palæontological evidence that grasshoppers, not greatly different from present forms, fiddled away among the carboniferous ferns, and enlivened the dense atmosphere of those preadamic times.

---

* "Sounds become inaudible to many persons when they are derived from vibrations more rapid than 25,000 per second, and when the number reaches 38,000, the limit of human perceptibility is attained; thus, the shrillness of a note may prove a hindrance to its study. This is illustrated by Tyndall in his recent book on sound. He writes: 'Crossing the Wengern Alps with a friend, the grass on each side of the path swarmed with insects, which, to me, rent the air with their shrill chirruping. My friend heard nothing of this, the insect world lying beyond his limit of audition.'"—Scudder; *American Naturalist*, II, 113.

The grasshoppers, however, are not heard till into July, for though they are hopping about during the early part of the growing season, they do not attain their wings till the time indicated. Thus, during spring, while our birds are making love, and the males rival each other in their attempts to please the females with happy, jubilant song, Dame Nature is rearing a troupe of insect musicians, which, in their turn, will string their lyres and play their courtship-tunes in the later seasons, when the song of the feathered performers is mostly hushed.

Leyden's lines—

> Oft have I listening mused the sultry day
> And wondered what thy chirping song might say—

but express an inquiry often made as to the purpose and object of the grasshopper song. He who believes all things made for man and his enjoyment, and that nothing can have a purpose that does not include him in its scope, will not find an answer to the query; and should remember that ere man grew out of savagery the earth rang again with song and sound. Nor will the poet be likely to get from Katydid any more satisfactory answer than that—

> "I sit among the leaves here, when evening zephyrs sigh,
> And those that listen to my voice I love to mystify;
> I never tell them all I know, altho' I'm often bid,
> I laugh at curiosity, and chirrup, 'Katy did.'"

But to the mind of the naturalist, trained in deciphering Nature's hieroglyphs, the chattering song is very plainly inspired by love. The male Katydid doubtless feels something of the same satisfaction in playing to his companions, and especially to Katy, as a prima donna does in singing to an audience. There is a pleasure in the act which is the outcome of its being; and the fact that the males are principally the players, shows that the gift is not only a source of pleasure, but one of much importance to the species; for the rivalry among the males is as great as among higher animals, and a good instrument becomes, in this light, most important to the individual and to the species. The best player wins his coveted love, while the feeble and cripple stand no chance to impair the vigor of the race.

The Locusts* (*Acrididæ*) stridulate for the most part by rubbing the inner surface of the hind legs against the outer surface of the

* It is to be regretted that American entomological writers do not more strictly follow Harris in conforming to the English custom of calling these insects—with short antennæ and stridulating by means of the stout hind legs—by the popular term of "locusts," which is in keeping with ancient usage. The term "grasshopper" would then be confined to the long-horned and long-legged, green group, stridulating solely with the wings, in which the species are more solitary and never congregate in swarms, and in which the female is invariably provided with a sword- or cimeter-shaped ovipositor; while the term Katydid could be used to designate the few larger, tree-inhabiting species of the group, so designated by Harris. Where the habit of calling the Cicada "Locust," and the "Locust" of ancient usage "Grasshopper," is as inveterate as in this country, it is not easy to change it; but it seems to me that the change is desirable, and if popular authors would only continue the example of Harris, the change would come about with the greater dissemination of entomological information.

wing-covers; a few stridulate during flight by rubbing together the under surface of the front and upper surface of the hind wings. The Crickets (*Gryllidæ*) stridulate by rubbing together the strong middle veins at the base of their wing-covers; while the Katydids stridulate by friction of the large veins situated mostly on the inner margin of a talc-like plate at the base of the wing-covers.†

We have in this country four Katydids that are tolerably common. They all dwell among trees and shrubs, and might far more appropriately be called tree-vaulters than grass-hoppers. They are all of a green color, with very long, slender legs and antennæ, and the females are all furnished with curved or saber-shaped ovipositors, formed of two pairs of flattened sheaths which inclose two narrower pieces. The base of the front tibiæ or shanks is somewhat dilated, with an oval cavity each side, closed by a membranaceous covering. In the Oblong-winged species, the first and middle shanks have such cavities, but in the other three species, it is found only on the front shanks.

Before passing to the consideration of our individual Katydids, I wish to call especial attention to the fact that, so far as is recorded, their representatives belonging to the same family in Europe all oviposit in the ground. As a rule, in animal and plant life, a special organ subserves some special purpose. The front limbs in the Bat, by a great elongation of the finger-bones, subserve the purpose of wings; in the Whale they are shortened so as to answer the purpose of fins; and in the Mole they are wonderfully modified for digging, very much in the same manner as we see them modified in such burrowing insects as the Tumble-dungs and Mole-crickets. Sometimes—as in the singular case mentioned by Darwin, who found, on the treeless plains of South America, a species of wood-pecker which still retains the climbing feet of the true wood-peckers, although there are no trees for it to climb—a species deviates from the habits of its family, and no longer has occasion to use a certain organ, which, nevertheless, it retains in a rudimentary condition.

Misled by Harris, who, in the earlier edition of his work, stated that all our grasshoppers laid their eggs in the ground, and in the last edition, expressly states (p. 156) that some of them—*e. g.*, the meadow-grasshoppers—do so; and conceiving, also, from the statements of Harris, that all our Katydids fastened their eggs externally to twigs, Mr. Walsh considered the ovipositors of these Katydids rudimentary, and the habit exceptional. He wrote, under date of February 17, 1863, in the *Prairie Farmer*: "Why, while many other families of insects, which deposit their eggs on the surface of twigs, have no ovipositor, the common Katydid and several allied

species should have one, is difficult to explain on the common theory of the independent creation of species. On Mr. Darwin's theory, the reason becomes at once apparent. Unless we choose to adopt that theory, all we can say is that *Natura non agit per saltum*—Nature does not proceed by sudden leaps—which is rather stating a fact than explaining the reason of that fact."

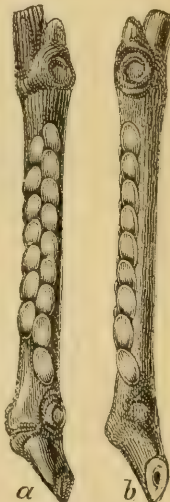
The truth, however, is that, so far as we have any evidence, none of the true grasshoppers, in the sense that the term is here employed, oviposit in the earth. *Xiphidium* oviposits in the cone-like willow-gall (*salicis strobiloides.*) *Conocephalus* has been observed by Mr. S. I. Smith "with the ovipositor forced down between the root-leaves and the stalk of a species of *Andropogon*, where the eggs are probably deposited"; * and I have good evidence that *Orchelimum* oviposits in twigs. It also appears, from the facts here recorded, that only one of the true Katydids is known with certainty to oviposit externally. Mr. Walsh's premises being wrong, therefore, his conclusions are valueless ; and, while I can conceive that all these different ovipositors have been modified from some archetypal form, I can not consider any of them rudimental. They are all most admirably adapted to the habits and wants of the possessors

THE ANGULAR-WINGED KATYDID—*Microcentrus retinervis* (Burm.)

[Fig. 43.]

EGGS OF MICROCENTRUS RETINERVIS :—*a*, front; *b*, side view, just before hatching.

[Fig. 44.]



EGGS OF MICROCENTRUS RETINERVIS :—*a*, front; *b*, side view, soon after laid.

This is by far our most common Katydid, and has been long confounded with the Oblong-winged Katydid. From having one of my earlier specimens marked for me with the latter name, I had myself frequently thus referred to it,† until I had occasion to study the four species more closely. It has large and ample wings, and the outer borders of the wing-covers form quite an angle (Fig. 45, ♂.) The hind thighs are comparatively short, and the ovipositor of the female (Fig. 46, *a*, *b*) is very short and much curved, being but little longer than the feet, squarely cut off, and bluntly toothed at the end, as in the illustration (*b*). The eggs of this species, (Figs. 43 and 44,) from their regular arrrangement and exposed position, are constantly attracting

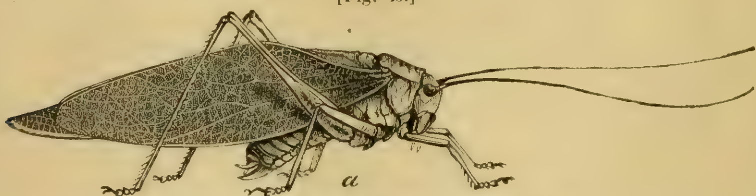
* Packard's *Guide*, p. 567.

† In my last Report (p. 123,) this insect is everywhere referred to, by mistake, under the name of *oblongifolia*.

the attention of the curious. They are more or less flattened, usually of a slate-color, but sometimes inclining to brown, and are deposited in two rows overlapping each other. Harris,* in a letter, (without date,) written to Miss Morris, from whom he received these eggs, very doubtingly referred them to the Oblong-winged Katydid, suggesting, at the same time, that they might belong to the common Walking-stick, (*Spectrum femoratum,*) whose eggs, however, are quite different, being smaller and spherical.

In the first edition of his well-known work on the "Insects Injurious to Vegetation," he speaks, in general terms, of the habit which allied insects in Europe have of depositing their eggs in the ground; but in the third edition of the same work, these slate-colored, mussel-shaped eggs are referred to the true or Broad-winged Katydid, while those of the Oblong-winged species are said to strikingly resemble them in form, size, color and arrangement. These statements have misled all subsequent writers. Several years ago, I first reared the Angular-winged Katydid from such eggs, (Fig. 43,) and finding others somewhat broader and flatter, (Fig. 44,) very naturally inferred, from what Harris said, that these might belong to the Broad-winged species. But after rearing nothing but *retinervis* from such eggs every year since 1868, no doubt remains in my mind that all these external eggs belong to this one species, and that, as stated last year, "the difference in size, and especially in thickness, which is so noticeable in them, depends on the variable size of the parent and on the degree of maturity of the eggs."

[Fig. 45.]



MICROCENTRUS RETINERVIS:—Male, wings closed.

The females commence to oviposit early in September, and continue to lay at intervals until the first severe frost. The eggs are occasionally deposited during the day, but the operation usually takes place at night. Selecting a twig of about the size of a common goose-quill, this provident mother prepares it for the reception of her eggs by biting and roughening the bark with her jaws for a distance of two or three inches. This bite is not gradual like that made when feeding, but is sudden and vigorous, the insect chewing and pressing the twig each side so as to form an edge. This operation is accompanied by a sudden nervous shake

[Fig. 46.]

MICROCENTRUS RETINERVIS:—*a*, ovipositor of female, nat. size; *b*, tip of same enlarged

* Correspondence, p. 241.

of the body from side to side, and lasts sometimes but two or three minutes, sometimes more than ten.* When the operation is accomplished to her satisfaction, she clutches with her front feet the stem to be used, and anchors the middle and hindmost feet for the most part upon contiguous leaves or branches, and often quite wide apart. Then, if she has her head in an upward direction (for it seems to be immaterial to her whether the eggs are placed from below up or *vice versa*), she begins at the lower end of the roughened portion of the twig, and, after fretting it anew with her jaws and measuring and feeling it over again and again with her palpi, as if to assure herself that all is as it should be, she slowly—with much apparent effort, and not without letting it partly fall several times—curls the abdomen under until the lower edge of the curved ovipositor is brought between the jaws and palpi, by which it is grasped and guided to the right position. It is then worked slightly up and down for from four to six minutes—all the time guided by the jaws—while a shiny viscid fluid is given out apparently from the ovipositor. Finally, after a few seconds rest or suspension of this work, the egg gradually rises, and, as it passes between the ovipositor, turns so that the one end appears almost simultaneously, from between the convex edge, with the other from the lower tip, of the blades. The egg adheres to the roughened bark in an oblique position. It is at first almost black and highly varnished, but it acquires its normal gray color within eight or ten hours. After the egg is placed the abdomen is straightened out and the insect rests for a few moments, soon, however, to resume her efforts and repeat the like performance, in every particular, except that the second egg is placed on the opposite side of the twig and a little above the first one. The third egg is pushed in between the top of the first one and the twig, the fourth between the top of the second, and so on, one each side, alternately. Thus these eggs are not laid, as we might naturally imply,

[Fig. 47.]

MICROCENTRUS RETINERVIS:—Female ovipositing.

* Harris thought that the bark was first roughened and shaved off by the ovipositor; while Mr. Walsh, writing to the *Prairie Farmer* (as already quoted, p. 154) states that "portions of bark between and under the eggs which are not concealed by the cement are neither shaved off nor roughened;" which is true in degree but conveys a false impression, as the roughened and gnawed parts are effectually covered by the cement.

one over the other, but, rather, one under the other: i. e., each succeeding pair having their ends thrust in between the tops of the preceding pair, the teeth at the end of the ovipositor helping to crowd the end into place.

The length of time required from the commencement of the fretting of the twig to the proper placing of the egg varies all the way from 5 to 20 minutes. Sometimes, as for instance where a bud comes in the way, the preparation of the twig will require a comparatively long time, and after the ovipositor is brought up and a futile attempt made to place the egg, it will be let down again and the work of preparing the twig more vigorously prosecuted a second time.

The number of eggs laid at one time varies from two to thirty, the first batches containing more than those deposited later in the season. Each female produces from one hundred and fifty to two hundred, or perhaps more, and I have known them to lay on the edge of a leaf, or of a piano-cover, or along a piece of cord.

These eggs, as already remarked, are rather flat when laid, but become more swollen, so that they have a narrower look as they approach the hatching period in spring. During the early part of May, the embryo larva—which lies straight in its egg, completely filling it, with the legs bent up as in a pupa, and the long antennæ curling around them—attains its full development, and after hours of tedious contracting and expanding movements, manages to burst the egg open at its top or exposed end, along the narrow edge, and generally about half-way down. Through this opening young Katy slowly emerges, undergoing a molt during the process, and leaving its first skin, in a crumpled white mass, attached to the empty bivalvular egg-shell. Including hind legs and antennæ it measures, at this time, rather more than an inch in length, the body alone being one-eighth of an inch long; and in contemplating it, one cannot but wonder how the long, stiff legs and great length of antennæ, together with the plump body, could so recently have been compressed into the comparatively small shell to which we see it clinging.

In from ten to twenty minutes after hatching, these little beings essay their first leaps, and soon begin to eat with avidity. They feed with almost equal relish upon a great variety of foliage, but I have found that when reared upon very succulent leaves, such as lettuce, cabbage, purslain and the like, they are less hardy, and do not attain so great an age as when nourished upon more ligneous food, as the leaves of Oak, Apple or Cherry.

The larval life of these insects lasts from seven to eight weeks. Shortly before the change to pupæ, which takes place toward the end of June, the rudiments of the wings and of the sexual organs may be

distinguished. In the pupa state they are quite pretty, and their faces have a comically wise look, and every motion is invested with a sort of dignity that can not fail to amuse the observer.

Including the molt in leaving the egg, they cast their skins five times, becoming pupæ at the fourth and acquiring wings at the fifth. In each case the palpi are adroitly used to help the long antennæ out of the old skin, and a description of the last, which is more easily watched, will convey a correct idea of all. In changing from the pupa to the perfect form, the insect stations itself firmly upon a large stem, or a couple of twigs which branch in such a manner as to afford a convenient support, and, after a short period of inactivity, a rupture appears in the covering of the head, and gradually extends backward to the posterior edge of the thorax. The armor of the head is next detached from the neck, and by a few upward and downward motions is made to slide off in front, the long, thread-like antennæ being drawn out of their sheaths with great care, in constantly lengthening loops, the palpi affording much assistance in pushing the old skin downward. After the head and antennæ are entirely freed the insect remains for a short time motionless, as if to recover from its exertions. Very soon, however, it renews its efforts in a series of rapid jerks and contractions by which the body is impelled forward while the outgrown skin is held firmly in place by the claws of the middle and posterior legs, which remain fixed in the wood. The most difficult part of the whole process seems to be the extrication of the front legs. This once accomplished, the Katydid has something to grasp with, and experiences no further trouble in withdrawing the body and the remaining legs from the old integument, often leaving the latter, as an almost transparent shell, in perfect shape upon the twig. It is not allowed to remain long, however, as an object of curiosity, for almost the first efforts of the transformed insect are directed to the task of eating up this, its out-grown and out-worn garment.

When first out of its pupal covering, the wings of the mature insect hang down on each side as flexible and shapeless as strips of dampened lace, but they soon begin to dry and harden, and are, by degrees, drawn up into place. Tne anterior pair, which were at first transparent, become gradually green and opaque, and display the characteristic leaf-like veinings; while the broad under-wings, formed of transparent membrane intersected by an exquisite net-work of green veins, are folded fan-like beneath them, with only the tips, for about a third of an inch, visible, this portion being green and thickened like the wing-covers. The whole operation of molting is performed within an hour.

The first notes from this Katydid are heard about the middle of July, and the species is in full song by the first of August. The wing-

covers are partially opened by a sudden jerk, and the notes produced by the gradual closing of the same. The song consists of a series of from twenty-five to thirty raspings, as of a stiff quill drawn across a coarse file. There are about five of these raspings or trills per second, all alike, and with equal intervals, except the last two or three, which, with the closing of the wing-covers, run into each other. The whole strongly recalls the slow turning of a child's wooden rattle, ending by a sudden jerk of the same; and this prolonged rattling, which is peculiar to the male, is invariably and instantly answered by a single sharp "chirp" or "tschick" from one or more females, who produce the sound by a sudden upward jerk of the wings.

Both sexes are for the most part silent during the day, but during the period of their greatest activity their stridulations are never for an hour remitted, from the time the great setting sun hides behind the purple curtains of the west till he begins to shed his scarlet rays in the east—the species being so numerous that the sound as it comes from the woods is one continuous rattling, not unlike the croaking of the frogs, but set to a higher key.

Mr. Scudder, who, in the article from which I have already quoted, (*ante*, p. 152,) gives an interesting account of the songs of some of our Grasshoppers, and endeavors to set them to music, remarks, in speaking of these Katydids, that they, "like the crickets, sing both by day and night, but, unlike the latter, their day-song differs from that of the night. On a summer's day, it is curious to observe these little creatures suddenly changing from the day to the night-song at the mere passing of a cloud, and returning to the old note when the sky is clear. By imitating the two songs in the day-time, the grasshoppers can be made to respond to either at will; at night, they have but one note." I do not know of how many species this will hold true; but with the Angular-winged species, I have noticed no particular difference in the day- and night-note, except in the greater intensity of the latter.

These insects make quite interesting pets, and if accommodated with a good-sized cage will pursue their duties and their pleasures almost as unrestrainedly as if in their native tree-tops. They are capable of domestication to a certain degree, and become so accustomed to the hand of their keeper that they will sit quiet while the cage is being cleaned and fresh supplies of leaves introduced. They are commendably neat in all their habits, flinging the excrement a great distance away from them by means of the hind feet, and employing the intervals between feeding in incessant polishing of wings, legs and antennæ. They brush their faces over with their front legs exactly as a cat washes herself with her fore paws, and they bestow as

much attention upon their long, graceful antennæ as many a maiden does upon her abundant tresses, drawing them between their jaws and smoothing them with the palpi with evident satisfaction.

I have reared three broods successively from eggs deposited in the cage. The first year no ill effect seemed to be produced by the confinement. The insects ate as greedily, stridulated as noisily and oviposited as freely as those which roamed at will out-doors; and I even succeeded in keeping some in a warm room, feeding on apples up to December 6, 1869, or more than two months after the unhoused specimens had ended their autumn feast and retired to endless rest. All the eggs from this first domesticated brood hatched the following spring, but the progeny was not quite so hardy, did not live so long, nor leave, in proportion to their numbers, so many eggs as their immediate parents. The third spring about half the eggs failed to hatch, and evidences of degeneracy began to be manifest in the slower growth and numerous deaths while molting. None of the insects acquired their wings until the latter part of August, and when they did the majority were deformed. But few eggs were laid, and these were placed with less regularity than formerly. The members of this third captive generation all died early in September, and their eggs, the next, or fourth spring, failed to hatch.

DESCRIPTIVE OF THE IMMATURE STAGES.

When first hatched the face is whitish-green, with the body of a more yellowish-green. It is covered, except on the head, with minute black spots, and there is a pale yellow medio-dorsal line, interrupted on the abdominal joints. The spots are placed in transverse rows on the posterior edge of each joint, but are scattered irregularly on the legs. The antennæ are nearly five times as long as the body. The color of the mature larva is dark yellowish-green above, with a bright yellow line along the top of head, continuing along the narrow ridge on the top of the thorax and along the first three abdominal joints, from whence two narrow lines diverge, run along the upper border of the abdomen and approach again at the anus. The sides are whitish or pale bluish-green, mottled with a still paler shade, and with an abdominal row of yellow dots and a continuous whiter line below them; venter still paler.

The pupa is colored and marked very similarly, but the yellow, dorsal lines are sometimes salmon-colored, or pink. The wing-pads appear as conspicuous fan-shaped appendages. The covering of the head has the appearance of being composed of tiny, over-lapping scales of a green color, outlined by a narrow edge of white. The labrum is long, somewhat horse-shoe shaped, and bordered with cream-white; mandibles dark brown, strongly toothed, concealed, except when the insect is eating, by the broad, bilobed, lip-like maxillæ; labium rather small, bifid; maxillary and labial palpi long, filiform, kept in almost incessant motion, and performing several functions besides that of selecting the food. The eyes are greenish-brown, round and prominent. The filiform antennæ are from two to three inches in length and seem acutely sensitive to touch.

NATURAL ENEMIES.

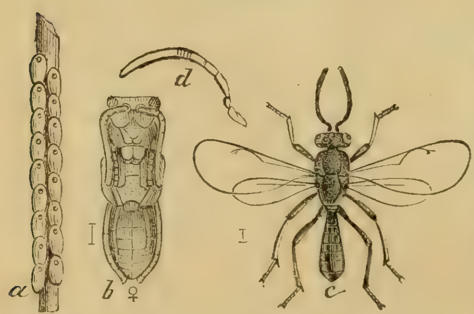
[Fig. 48.]

ANTIGASTER MIRABILIS:—*a*, female, wings expanded, nat. size indicated underneath; *b*, same, side view partly rolled up; *c*, same nearly rolled up; *d*, antenna of same.

Crows and blackbirds are known to devour the perfect insects, but one would suppose that the hard-shelled eggs would remain entirely unmolested by predaceous animals. Yet I once found two of these eggs in the stomach of a Baltimore Oriole, associated with the elytram of some beetle, the wings of a wasp (*Trypoxylon*) and many seeds. They are also quite often infested by a curious little Chalcid-fly—the *Antigaster mirabilis* Walsh—which may be popularly called the Back-rolling Wonder. This little fly was very fully described, both generically and specifically, in a posthumous paper of Mr. Walsh's (*American Entomologist*, II, pp. 368–370). Mr. Walsh had captured three females at Rock Island, Ills., but neither the male nor the habits of the species were known until I bred specimens from the eggs of our Angular-winged Katydid. I have bred it from such eggs received from Kansas, several parts of Missouri, and from Chattanooga, Tenn.; also from the eggs of a large Sphinx moth found on Willow; so that it is quite wide-spread, and not strictly confined to Katydid eggs.

The anomalous nature of this little fly consists in the habit possessed by the female (Fig. 48, *a*, *b*, *c*) of rolling up into a ball backward, and in the very great dissimilarity of the male (Fig. 49, *c*). Many other insects roll up downward, with a convex back, while some few, as the Rove-beetles, (*Staphylinidæ*), curl up more or less backward when disturbed; but no other species is so curiously constructed for rolling backward into a perfect ball, unless it be some belonging to the very closely allied genus *Eupelmus*.

[Fig. 49.]



ANTIGASTER MIRABILIS :—*a*, eggs of Microcentrus from which it has issued; *b*, female pupa, ventral view; *c*, male fly; *d*, his antenna.

I shall append in a foot-note, for the benefit of the sci-

entific reader, Mr. Walsh's description of the female and my own of the male.*

These little parasites have always issued in the spring of the year, just about the time when the young Katydids would have issued if they had been unmolested; but as Mr. Walsh captured his specimens in August and September, the insect must either be double-brooded, or the female must survive during the summer months. As I have bred it from Sphinx eggs, the first is doubtless the correct hypothesis. The larva of this little anomaly I have not yet met with, but the pupa (Fig. 49, *b*) is characteristically flattened and straightened to suit it to its narrow egg-abode. When mature, and not till the wings are expanded and all its parts are hardened, the fly gnaws its way out through an irregular but usually round hole at the anterior or exposed end of the egg (Fig. 49, *a*).

The male, as will be seen upon glancing at the figures, approaches much nearer the more common Chalcididan form. He has clear wings, a narrower body, and is of a more brilliant metallic green color than the female, from which, indeed, he differs so much, that had I not bred both sexes from the same batch of eggs, we should scarcely believe them to be at all specifically connected. I never saw him roll

---

* ANTIGASTER MIRABILIS.— ♀ (Fig. 48, *a* back view, *b* curling up, *c* nearly curled up—both in profile). *Head* sub-opaque, finely and closely punctate; brilliant greenish-coppery with purple reflections. Mouth, including the clypeus, black Antennæ with the joints rather indistinct: the scape half as long as the other joints put together; joints 1-10 proportioned as 3, 9, 4, 6, 6, 4, 4, 4, 9; the scape rufous, the other joints brown-black, and those of the flagellum opaque. *Prothorax* rufous. *Thorax* above and on the pleura finely and shallowly rugoso-punctate and subpolished; the mesothoracic præscutum subopaque, equilaterally triangular, finely and closely punctate, and of a more or less brilliant greenish coppery color; the other thoracic pieces black, with blue and green reflections, except that the pleura is, sometimes, rufo-piceous on its disk. The sternum is polished, devoid of sculpture, and black, with metallic green reflections. Membranous parts before and on each side of the scutel rufous. A bright blue plate in the form of a rectangular triangle on each side of the metathorax, the rectangle outward and forward. *Abdomen* black, subpolished, glabrous, except a few short hairs toward its tip, basally slender and regularly widening, with its sides straight two-thirds of the way to the tip, thence regularly curved to the tip, which forms an obtuse angle. Joint 1 fully ½ as long as the rest put together, and yellowish semi-transparent white, except its basal ¼, and except that the base of joint 2 shows black through the transparent overlap of the terminal edge of joint 1. Sheaths of ovipositor white. *Legs* rufous; hind coxæ dusky, especially above; the four hind femora and tibiæ a little clouded externally with dusky, and the last tarsal joint in all six legs dusky. *Front Wings* dusky, shading into hyaline on their terminal 1-6 [this hyaline apical spot sometimes entirely wanting.—C. V. R.]; their basal ⅓ and a broad transverse widely interrupted band a little beyond the middle, both of them whitish subhyaline; veins and stigmatic branch brown. *Hind Wings* hyaline; veins pale brown. Length ♀ 0.13-0.14 inch.

Described from 3 ♀ taken upon herbage near Rock Island, Ills, in August and September; 2 ♀ with the thoracic parts elevated and the body more or less rolled up, the other ♀ with the thoracic parts depressed and the body extended; ♂ unknown. Nothing but the almost exact correspondence of all the complicated colorational and structural peculiarities, found in this insect, would ever induce any entomologist, unacquainted with this most remarkable genus, to believe that these three specimens are all identically the same.

♂ (Fig. 49 *c*).—Color brilliant metallic-green, with faint blue and purple reflections. *Head* very bright green, finely and closely punctate; eyes pale, with a dusky patch in front, smaller and further apart than in ♀; eyelets purplish; antennæ black and opaque throughout, cylindrical, of a more uniform thickness and proportionally rather longer than in ♀, reaching, if turned back, to the base of abdomen, whereas those of ♀ scarcely reach so far; 10-jointed, the joints proportioned as 3 (scape), 1, 3, 2, 2, 1-10, 1-10, 1-10, 1-10, 8 (club). [On a more critical examination of fresh specimens, I find that the joints are proportioned rather as 3, 1, 3, 2½, 2, 2, 1, 1, 1, 5.] Collare very short. *Thorax* above very finely punctate and subpolished, and either bright metallic-green or coppery-green, with faint purple reflections, the metathorax more bluish and more highly polished than the rest; built on a different plan from that of ♀; lacking the very prominent and characteristic prothorax, the præscutal triangular piece, and the square excavation, which occur in that sex, and more nearly resembling *Eurytoma*, *Decatoma*, etc., in the divisions of the mesonotum. *Abdomen* dark metallic blue throughout, glabrous, smaller and more uniform in diameter than in ♀; the joints distinguished with difficulty, but apdarently proportioned as in ♀. *Legs* with the femora all dusky with a faint bluish reflection; trochanters rufous; coxæ steel blue; front and middle tibiæ white; hind tibiæ dusky; tarsi all white, with occasionally (1 specimen) the terminal joint dusky, the middle pair lacking in a great measure the peculiar enlargement of basal joint. *Wings* more rounded than in ♀, perfectly hyaline, the stigmatic branch but faintly discernible. Length 0.09-0.10 inch.

Described from 3 dried specimens.

up backward as does the female, nor do I think he possesses this power; and he certainly has not the remarkable power, which she possesses, of setting up or depressing at will the mesonotal sub-segments, for his thorax is quite differently constructed.

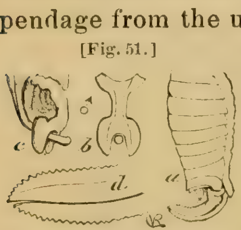
THE NARROW-WINGED KATYDID—*Phaneroptera curvicauda* (DeGeer).

[Fig. 50.]

PHANEROPTERA CURVICAUDA:—Female, after Harris.

This is our next most common species, and, according to Packard, it is the most abundant species in Northern New England. It is at once distinguished from the others by the length and narrowness of its wing-covers, and by the male having a cylindrical style curving from below upward, and resting in the forks of a curious furcate appendage from the upper end of the abdomen (Fig. 51, *c*, *b*). The ovipositor of the female is much curved, and about as long as the front thighs, more pointed than in *retinervis*, and regularly notched, both above and below, for about one-half its length (Fig. 51, *d*).

[Fig. 51.]



PHANEROPTERA CURVICAUDA:—*a*, ovipositor of female, nat. size; *d*, end of same, enlarged; *c*, anal appendage of male, side view; *b*, same, back view.

The wing-covers are flat, with the costal and inner edges parallel, except near the apex, about $\frac{1}{4}$ of an inch wide, and project when closed, full half their length beyond the body. They are more membranaceous, and of a duller, darker

green than those of the other species. The sides of the abdomen are glaucous-green, vaiegated with purplish reflections, and on the ventral surface the posterior edges of the joints are defined by lilaceous bands. The hind legs are remarkably long. The antennæ are of a reddish color for about half their length from the base.

This species hatches somewhat later and develops more slowly than the preceding, and in its adolescent stages is easily recognized by its more slender form, longer legs, and more gayly-colored appearance—the body being checkered with purplish, black, red-brown and white, the antennæ black with five white annuli, and the hind thighs having, more especially, two broad, dark annulations. By the time *retinervis* begins to sound its taboret, *curvicauda* is generally in the pupa state, while it seldom acquires wings till the fore part of August. The eggs are deposited singly in the edges of leaves, between the upper and under cuticles. The method of oviposition is thus described for me by Miss Murtfeldt, who has watched the operation: "The female stations herself firmly, by the middle and hind legs, on twigs or leaves contiguous to the one selected to receive the egg. This leaf is then grasped by the front feet and held in a vertical position, while the edge is slightly gnawed or pared off by the jaws to facilitate the entrance of the point of the ovipositor. When this is done the abdomen is curved under and brought forward, and the ovipositor is seized on its convex edge by the mandibles and maxillæ, which, with the aid of the palpi, guide the point to that portion of the leaf prepared to receive it. After gentle, but repeated, efforts, the point of the instrument is finally inserted between the tissues of the leaf, and gradually pushed in, to more than half its length. As soon as the cavity is formed, the egg is extruded, and passed slowly between the semi-transparent blades of the ovipositor. As the egg leaves the ovipositor, the latter is gradually withdrawn, while the egg remains in the leaf, retained in its place, probably, by a viscid fluid that is exuded with it. The insect occasionally deposits two or three eggs in succession, but, as a rule, after one is placed she releases the leaf and betakes herself to eating, or to biting her feet, or dressing her antennæ, and does not resume her maternal duties for some time."

I have had as many as five of these eggs deposited in a single leaf, in one contiguous row, but they are more often single. The egg is so very flat as scarcely to cause a noticeable swelling in the leaf; indeed, its position can only be determined by holding the latter against the light. It is somewhat narrower, in its broader outline, than that of *retinervis*, and slightly curved, but otherwise resembles the latter. Before hatching, it swells so as to become nearly cylindrical in form, raising the skin of the dry leaf into blisters.

The species is not so prolific as *retinervis*, as I have never obtained more than thirty eggs from one female. Nor does it bear confinement as well. It feeds mostly on oak-leaves, to which it has shown a preference, also, in consigning its eggs.

The shrill of the male is by no means so loud as of the Oblong-winged species, in which its sound is always drowned in the woods. It consists of a softer *zeep*, *zeep*, sometimes uttered singly, but generally thrice in succession. The call is occasionally responded to by a faint chirp from the females, produced by stretching out their wings as if for flight, and is as often heard in the day as at night.

Scudder says of this species: "His day-song is *bzrwi*, and lasts one-third of a second; the night-song consists of a repetition—ordinarily eight times—of a note which sounds like *tchw*. This is repeated at the rate of five in three-quarters of a second, making each note one-half as long as that of the day."

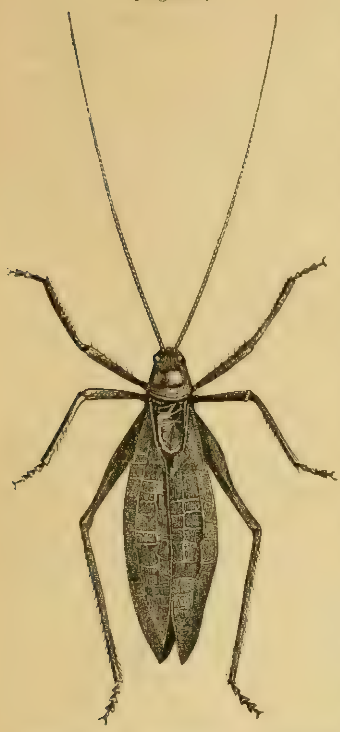
DESCRIPTIONS OF ADOLESCENT STAGES.

The body of the larva is flattened-pyriform, large and rounded at the posterior extremity, tapering from thence to the narrow, straight thorax, and widening again into the rather large head. The length, shortly after hatching, is nearly one-fifth of an inch, exclusive of the appendages. The posterior legs are about four times the length of the body, and the antennæ as long as body and legs together. The colors are purplish-black and white, on the head and body arranged in minute regular checkers. The legs and antennæ are principally of the dark color, annulated with white, and giving to the little animal a striking and histrionic appearance. It retains the same form and very much the same colors throughout the larval state—the legs getting to look as if pale, marked and annulated with brown—two annulations on the thighs being especially broad.

In the pupa state it is quite different, but no less elegant and characteristic in appearance. The form of the abdomen is more cylindrical and tapering toward the posterior end. The anal stylets of the male and the ovipositor of the female are distinguishable in a rudimentary state. The black and white colors disappear, and the insect is clothed in green, varied by purplish shadings on the sides. Two large, bright crimson spots adorn the top of the thorax, and a pair of small dots, of the same color, the top of each abdominal joint. The wing-pads are wider in proportion to their length than those of *retinervis*.

THE BROAD-WINGED KATYDID—*Platyphyllum concavum* Harr.

[Fig. 52.]



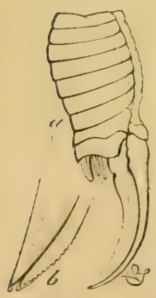
PLATYPHYLLUM CONCAVUM:—Male, after Harris.

This is our next most common species, and the true Katydid from which the popular name is derived. It is the only one of the four species, here treated of, in which the wing-covers are longer than the wings, and it is at once distinguished from all the others by the greater breadth and convexity of these wing-covers, which entirely enclose the abdomen, and, with their strong mid-rib, look exceedingly like a leaf. The species is, withal, so familiar to most persons, and has been so well described by Harris, that I shall touch only on its more striking characters, or on such traits as are not generally known.

The ovipositor of the female (Fig. 53, *a*, *b*) is almost as long as the abdomen, cimeter-shaped, sharp-pointed, and with but slight serrations on the lower edge toward the tip. Both sexes have two thorn-like projections on the breast, between the front legs, and the membranaceous spots on the dilated base of the front tibiæ are convex rather than concave, and look like little pockets, from above.

The eggs are thrust, by means of the sharp ovipositor, into crevices and soft substances, and probably, in a state of nature, into the crevices of loose bark or into the soft stems of woody plants. In the breeding cage I have had pieces of cork filled with them, and they have often been crowded between the crevices and sutures of my cages, especially where the cap rests on the cage proper. These eggs are 0.25–0.30 inch long, very flat, over thrice as long as wide, pointed at each end, with the edges beveled off or emarginate (Fig. 54, *a* side view, *b* front view, enlarged, *c*, *d* natural size). They are of a dark slate color, and the lower or first inserted end is protected by a dark, adhesive substance, which hardens and sometimes extends the whole length of one of the borders. Several eggs are usually pressed close to each other.

[Fig. 53.]



PLATYPHYLLUM CONCAVUM:—*a*, ovipositor of female, nat. size, *b*, end of same enlarged.

With the exception of Harris's account of these eggs, which is erroneous, the only other account which I know of, that is not copied from Harris, is that by B. Jaeger in his "Life of N. A. Insects" (p. 108), where he unequivocally states that the female pierces holes in the ground for the purpose of depositing her eggs, and then goes on to describe how "a very close and interesting observation of the conduct of these insects may be made every autumn by putting a pair of them into a wide glass vessel, having the bottom covered with turf, which, however, must be sprinkled with water every day. As soon as the evening begins the female will commence laying her eggs and depositing them in the ground, and the male will announce in loud tones that Katy-did-it. If you preserve these eggs in the turf through the winter, and open them in the following spring, you will find the insect in a perfect condition, except being destitute of wings."

[Fig. 54.]

PLATYPHYLLUM CONCAVUM:—*a b*, egg, side and front view, enlarged; *c*, *d*, same, nat. size.

Now, when a man describes in detail a process like the above, one naturally concludes that he has witnessed what he describes, and were the above from almost any other author than Mr. Jaeger, I should be inclined to respect it; but there is so much nonsense and false statement in Mr. Jaeger's book, that I have no doubt that the passage describes an imaginary process, adapted from the account of some European grasshopper in which it may be observed; for if our Katydid ever oviposited in the earth, it would have had abundant opportunity of so doing in cages where I have kept it.

The talc-like plate at the base of the wing-covers of the male is quite transparent, strongly-ribbed and surrounded by ridged veins, while in the other three species, the overlapping portion is no more transparent than the wing-cover itself. The stridulation is quite forcible, representing more often, "Katy-she-did" than "Katy-did," and continued at regular intervals. It is seldom heard in the day, but as soon as the stars begin to show in Heaven's ebon vault, the familiar song of this male *concavum* blends in the distance with the more numerous trills of his cousin *retinervis*, but is distinct and separate when closer to ear.

I have had no opportunity of making notes of the adolescent stages.

THE OBLONG-WINGED KATYDID—*Phylloptera oblongifolia* (DeGeer.)

[Fig. 55.]

PHYLLOPTERA OBLONGIFOLIA:—
Outline of female, with (*b*) enlarged end of ovipositor.

This species I have not yet found in Missouri, but it is abundant in New England, and is found farther north than either of the other three. It is at once distinguished by the perfectly oval form of the wing-covers, the long hind thighs, and by having the base of the middle as well as of the front tibiæ swollen and furnished with a membranaceous cavity each side. The female (Fig. 55,) has an ovipositor intermediate in size between those of the Broad and Narrow-winged species, or almost as long as the abdomen, and it is more strongly toothed for one-half its length (Fig. 55, *b*) than in any of the others. The notes of the male are described by Harris as, though grating, comparatively feeble.

The eggs of this species are not known, though, as already stated, those of the Angular-winged Katydid have very generally been supposed to belong to it. From the structure of its ovipositor I have little doubt that it will be found to oviposit above ground, and probably within the soft stems of some plant. I hope some of my more northern entomological friends will endeavor to ascertain the precise whereabouts, and thus complete our knowledge of the habits of the American Katydids.

Though the color of the species is green like the others, I have an abnormal female specimen, received from Prof. G. Thurber, of New York, which is uniformly of a deep fleshy-pink, without a spot of green, the color not artificially produced, but occurring in life.

INDEX.

A

G

H

M

N

O

Q

R

S

V

W

X

Y

ERRATA.

Page 23, line 5, for "adopt" read "adopts."

Page 51, line 2 from bottom, for "*insidious*" read "*insidiosus*."

Page 154, line 6, omit the †.

SEVENTH ANNUAL REPORT

ON THE

NOXIOUS, BENEFICIAL,

AND OTHER

INSECTS

OF THE

STATE OF MISSOURI,

MADE TO THE STATE BOARD OF AGRICULTURE, PURSUANT TO AN APPROPRIATION FOR THIS PURPOSE FROM THE LEGISLATURE OF THE STATE.

BY CHARLES V. RILEY,
State Entomologist.

JEFFERSON CITY:
REGAN & CARTER, STATE PRINTERS AND BINDERS.
1875.

PREFACE.

To the President and Members of the Missouri State Board of Agriculture:

GENTLEMEN: The following pages constitute my Seventh Annual Report on the Noxious, Beneficial and other Insects of the State of Missouri.

As its contents show, the year 1874 has been remarkable for the wide-spread suffering that insects injurious to Agriculture have entailed, especially in the Mississippi Valley and the country to the West. Our own State, though not suffering so much as some of her sister States, did not escape immense injury. Added to a severe drouth, which shortened most crops, our farmers suffered much more than usual from the ravages of the Chinch Bug; while in the western counties they also suffered from the visitations of the Rocky Mountain Locust, or so-called "Grasshopper," which spread such desolation over so large a portion of the fair West. Both these insects receive that large share of attention in the present Report which their importance and the interest just now attaching to them demand. Still a third insect, namely, the Flat-headed Apple-tree Borer, has been unprecedentedly abundant and injurious to our fruit and shade trees, and it gives me pleasure to lay before the people some new facts which will help to a better mastery of it.

A law passed by the last Legislature not only changes somewhat the mode of binding and distributing the Agricultural Report, of which this forms a part, but increases the edition from six to twelve thousand, and limits the number of pages it shall contain to 500. Finding that the articles on the noxious insects, of which this Report treats, occupy more than the ordinary number of pages allotted to me, I have deviated somewhat from previous custom, and omitted the chapters on Beneficial and Innoxious Insects, with which its predecessors have ended. In the article on the Rocky Mountain Locust, the reasons are given at length why I believe that this plague will never do serious harm beyond a certain line there indicated. It gave me no small satisfaction to be able to allay last Fall the fears our farmers east of that line entertained of being overrun by the pests. For some years past, Kansas, by one means and another, and especially by a liberal policy on the part of her Legislature toward her State Horticultural Society, has done all in her power to attract immigration. Our own State government has repeatedly refused the appeal of our State Horticultural Society for small appropriations to enable it to exhibit the fruits and advertise the resources and capabilities of the State; and other measures intended to encourage immigration have been left without support. The consequence of such legislative neglect, and of other less avoidable occurrences, was seen in the trains of emigrant wagons that during the last two or three years have been passing through our State, bound for Kansas or

some more western point. The locust invasion of 1874 checked the tide of emigration to Kansas and the further West, and even turned it back again; and I have every reason to believe that the assurance that Missouri is essentially safe from the devastations of these locusts will have no inconsiderable influence in staying that immigration within our borders in the future.

There yet are, and doubtless ever will be, those who—dwelling in cities, and familiar only with such lectularious insects as cause them bodily inconvenience—have little appreciation of Agriculture or of Entomology in its connection with it; and consider the study of "bugs," as they contemptibly call everything that creeps, a fit subject for ridicule. When, however, a single insect, like the Chinch Bug, filches nineteen million dollars, in a single year, from the pockets of the farmers, and reduces in so much the wealth of the State; even such persons may be brought to admit that any study having for object the reduction of this immense loss, is not necessarily contemptible, small as the objects may be with which it deals. Fortunately, such persons are becoming fewer and fewer, and the following pages bear witness to the fact that not only in several States in our Union, but in several countries of the "Old World"—in monarchies, empires and republics alike—the authorities have manifested a remarkable appreciation of economic Entomology. We have, during the year, witnessed Australia and New Zealand discussing and attempting the introduction from Europe of Aphis parasites to check the alarming increase of those plant pests; and of bumble bees to enable the farmers to grow their own clover seed. We have seen France increasing her premium for a Phylloxera remedy to three hundred thousand francs, and considering plans, for the destruction of the pest, of constructing an irrigation canal to supply 60,000 acres. We have seen Massachusetts memoralizing her Legislature to pass "An act for the destruction of Insects Injurious to Vegetation;" while some of our own State Legislatures have been convened in special session to consider means of relieving the sufferers from insect ravages, and several European governments have, with forethought and wisdom, taken such measures as seemed best to prevent future injury from still other insect pests.

The fact that the Agriculture of the United States is of equal material importance with all the other interests of the country combined is so often asserted and admitted that it needs no enforcing. This industry not only feeds our own forty million mouths, but supplies the staff of life to millions in foreign lands. Surely, then, it is most important to study and investigate those causes which affect it injuriously and arrest its development, among which injurious insects play such an active part. When, as last year, the prosperity of whole States is jeopardized, and the whole nation suffers most sensibly from these depredators, national measures should be taken to investigate the causes and endeavor to prevent the recurrence of such disasters in the future. I have already referred to the immense loss which the Chinch Bug caused us last year, my estimates being based on returns obtained from farmers from the different counties. Yet, though the sum demonstrably amounts to millions, many of our legislators and some of our journalists would laugh at me were I to ask for an appropriation of five or ten thousand dollars to be expended in experiments which might result in giving us a perfect, or at least a much better remedy for the evil than any now in our possession, and thus save the whole or the larger part of this immense annual loss. Experiments on a sufficiently thorough and extensive scale can never be undertaken by the few State entomologists now employed, with salaries of two or three thousand dollars, from which they pay their expenses. The means will not justify them and the time of such officers is

occupied with the study of not one or two, but of hundreds of species, many of them local in character. In cases, as with the Locust, the Chinch Bug, the Cotton Worm, etc., where the evils are of a national character, a national Commission, appointed for the express purpose of their investigation, and consisting of competent entomologists, botanists and chemists, is necessary, and should be demanded; and I am glad that preliminary steps have been taken by some of our leading scientific men to memoralize Congress to create such a Commission, the members to be chosen by the Council of the National Academy of Science, and approved by the Secretary of the Treasury.

We have, it is true, a Department of Agriculture which, if under intelligent and scientific control, might employ the large sums it now fritters away in the gratuitous distribution of seeds, to better advantage in organizing and sending out such a Commission; but the people have lost all hope of getting much good out of that institution as at present organized, or so long as the character of its head and management depends on political whim or fancy.

I have referred in previous years to the binding and distribution of the Entomological Report, and suggested that improvements might be made in the law. In some respects the new law, already referred to, is a great improvement on the old one, and will have a tendency to bring these reports before the farmers, in a manner in which they have not been brought before them in past years, if we may judge from the experience of the many whose letters I partly publish in the Chinch Bug Appendix. My 6th Report was published last April, and a word or two as to its distribution may not be out of place. At the approach of Summer it began to be rumored, and it finally became manifest, that your late Corresponding Secretary, Mr. J. F. Wielandy, decided not to publish a report. As mine is bound in by law with that of your secretary, and I did not wish it to lay the whole year at the bindery, I took measures to have it bound and distributed separately, and, after conferring with the Governor and Secretary of State, and the officers of the Board, and getting the sanction of my intended course from each individual member of the Board, it was so ordered bound and distributed.

At the request of a committee appointed by the Board of Curators of our State University to confer with me on the subject, I agreed a year ago to prepare a collection of insects for the use of the Agricultural Department of that Institution. During the year I have devoted what little time I could spare, and all the time of an assistant, Mr. Lugger, not absolutely needed in other directions, to the preparation of this cabinet, which I took to Columbia last December, and delivered to the College. It consists of sixty drawers, 12 by 16 inches, with a depth of 2½ inches inside, and lined with cork and ruled paper—the drawers being of pine wood with cedar fronts, and the cabinet itself being of oiled walnut. It contains types of the principal insects of the State, with figures, in many instances, of their adolescent stages. These insects are all carefully mounted and properly classified, with printed, ordinal, family, generic and specific names attached, and where the species have been treated of in my Reports, there are references made to the particular Report and the particular figure. The whole forms a type collection intended for the instruction of the students, and to illustrate my lectures before the entomological class at the University; and in each drawer there is room left for the addition of specimens that may be collected by the students.

In these busy, stirring days, there are few men who get time to read through a Report on any specialty—even among those for whom such a report is more particularly intended. In the work herewith submitted there will be found matter that will interest the scientific as well as the practical man; and, fully appreciating the truth of

the aphorism, *Ars longa, vita brevis est*, I have endeavored to so arrange and sub-divide the matter that the reader may refer at once to that which more especially interests and concerns him. In a work intended for future reference as well as present use, the topics are best discussed under as many sub-heads as possible.

In this, as in the previous volumes, when the insects treated of are new, or the existing descriptions of them are imperfect, or in a foreign language, or in works out of print or difficult of access, I have added a full description, which is, however, always printed in smaller type, so that it can be skipped by the non-interested reader. The popular name of each insect is accompanied by the scientific name, and the latter is generally printed in *italics* and mostly in parenthesis, so that it may be skipped by the practical man without interfering with the text. The Order and Family to which each insect belongs, are also given under each heading. The dimensions are expressed in inches and the fractional parts of an inch, and the sign ♂ wherever used, is an abbreviation for the word "male," the sign ♀ for "female," and the sign ☿ for neuter.

Many of the figures are enlarged, but the natural size of each of such is also given or indicated by a hair-line, except in the representation of enlarged stuctural details, where they are connected with the life-sized insect to which they belong.

The name of the author of the species, and not of the genus, is given as authority; and in order to indicate whether or not the insect was originally described under the generic name which it bears, I have adopted the following plan: When the specific name is coupled with the generic name under which it was first published, the describer's name is attached without a comma—thus indicating the authorship of the dual name: e. g. *Phycita nebulo* Walsh. But when a different generic name is employed than that under which the insect was first described, the authorship is enclosed in parenthesis, thus—*Acrobasis nebulo* (Walsh); except where the whole name is already in parenthesis, when a comma will be used for the same purpose: e. g., (*Acrobasis nebulo*, Walsh).

All the illustrations, except Fig. 30, unless otherwise stated, are drawn by myself from nature.

My office is still at Room 42, St. Louis Insurance Building, N. W. Corner of Sixth and Locust Sts., where all communications should be sent. I regret not to be able to thank the officers of our different railroad companies for courtesies extended on their different lines. The stringent regulations which the roads have adopted have prevented my obtaining the passes which in former years materially assisted in the prosecution of my work.

Respectfully submitted,

CHARLES V. RILEY,

State Entomologist.

ST. LOUIS, MO., April 1st, 1875.

TABLE OF CONTENTS.

NOXIOUS INSECTS.

THE COLORADO POTATO BEETLE—*Doryphora* 10-*lineata* Say.

(Ord. Coleoptera; Fam. Chrysomelidæ.)

IT REACHES THE ATLANTIC.

After narrating, in 1868,* how this insect had made its way from the Rocky Mountains, where it originally fed on the wild *Solanum rostratum* Dunal, till, in 1859, it reached a point one hundred miles west of Omaha, Neb.; how, in 1861, it invaded Iowa, in 1862, Southwest Wisconsin, and in 1864 and 1865, crossed the Mississippi to the western part of Illinois and eastern part of North Missouri; how, in 1866, it occupied most of the country west of a line drawn between Chicago and St. Louis; how, in 1867, it reached Southwest Michigan and West Indiana; and, finally, how, in 1868, it was already announced in portions of Ohio—I showed that its average annual progress eastward had been upward of seventy miles, and predicted that it would probably reach the Atlantic about A.D. 1878, or a few years earlier than Mr. Walsh had calculated some years previously, when he first traced its eastern progress and showed that it was traveling onward to the Atlantic, establishing a permanent colony wherever it went. In subsequent reports, its progress eastward was yearly recorded, and I now have to record that it reached the Atlantic at many points during the year 1874, or four years in advance of the time predicted—the increased average annual rate being due no doubt to the aid the beetles got in their onward course from ships on the lakes and from the cars on our railroads.

Early in the summer, I received undoubted evidence of its appearance on the Atlantic seabord, and it was reported during the year

---

*First Report, pp. 102-3.

from several parts of Connecticut, New Jersey, New York, Pennsylvania, Delaware, Maryland and Virginia.*

INJURIES DURING THE YEAR.

While the insect has been quite injurious in some of the Eastern States more recently invaded, it has attracted less attention than usual during the year in Missouri; for our farmers have come to consider it a necessary evil, and its destruction a part of potato culture. One rather curious circumstance in this connection relates to its increased injuries in its native home in the Rocky Mountains. It is a fact observed by many western travelers that the potatoes in the mountain regions of Colorado were less affected by the insect than were those of the Mississippi Valley. This was natural enough, since the wild food plants are common there, and the potato fields fewer and more scattered than further east; and, moreover, the stream which first branched off from the wild Solanum feeders, and took to feeding upon the cultivated potato and spreading eastward, doubtless took no backward course. During the past summer, however, the insect did great damage to the crops in the mountain region: yet a fact which is suggestive to the people in the Alleghanies is worthy of mention, and that is that while the injury reached three or four miles into the mountains, or to about the middle elevations (say 8,000 feet above the sea level,) the crop was entirely free from the insects above that altitude and yielded abundantly. This fact was communicated to me by several independent observers, and among others by Prof. J. H. Tice, who spent the summer at Left Hand Canon. Some observations of Mr. G. H. French, of Irvington, Ills., who also spent the summer in the mountains, to the effect that while he often found the bodies and eggs

* The following reports are the most trustworthy (the species having been identified in each instance) from among many others that might be given : The *American Farmer*, Baltimore, for July, 1874, says: "Not only in the vicinity of Baltimore, but all over the western shore of Maryland, in Delaware and in Virginia, these insects have appeared in great numbers, voraciously attacking the crops." H. P. reports it in Connecticut (*N. Y. Weekly Tribune*, July 22, 1874); E. B. M. in Cape May county, N. J., (*ibid*, August 26, 1874). In June it was at Wilmington, Del., (*Daily Commercial* of that place, June 1, 1874). E. T. reports it during the same month in Oneida county, N. Y., (*Country Gentleman*, June 25, 1874); C. F. at Olney, Md., (*ibid*, July 30, 1874). The monthly reports of the Department of Agriculture record it in Alleghany, Cattaraugus, Delaware, Erie, Madison, Tioga, Wayne and Wyoming counties, N. Y.; Burlington, Gloucester and Salem counties in N. J.; Kent county in Del.; Alleghany, Baltimore, Caroline, Cecil, Carroll, Dorchester, Frederick, Hartford, Montgomery, Prince George and Queen Anne counties, in Md.; and Culpepper, Fauquier, Greenville, Highland, Page and Prince William counties, in Va.

Finally, the following parties have reported its appearance to me by letter : Rev. John G. Morris, Baltimore, Md., from around that city; T. L. Harison, Secy. N. Y. State Agr. Soc., from around Syracuse, N. Y.; W. K. Shelmire, Toughkennamon, from Chester county, Pa.; S. Lockwood, Freehold, N. J., from that vicinity; S. S. Rathvon, Lancaster, Pa., spoke of its increase in Lancaster county; Thos. Meehan reported it swarming in June around Germantown, Pa.

above that altitude, yet the eggs, or the larvæ just hatched from them were dried up and dead, will suggest the reason, which is probably due to the very dry atmosphere in connection with the cool nights.

ALARM ABOUT IT ABROAD.

In earlier reports I have expressed the opinion that there would be real danger of the insect finding its way to Europe when once it reached the Atlantic seaboard; and now that it has done so, the authorities in several of the European countries are taking active measures to prevent such a possible calamity as the introduction of our potato beetle might prove. The potato, to some of the European peoples, is of more national importance than to us, and we cannot wonder at the alarm manifested across the water, or at the interest which the subject creates there, as evidenced in the number of pamphlets, both in French, German and English which have lately appeared on the subject in Europe, and the numerous articles written for the periodical press.

The governments of Belgium, France, Switzerland and Germany have already prohibited the importation of American potatoes, and Italy, the Netherlands and Great Britain, which have been solicited to do so, are seriously inquiring into the necessities of the case. The British Government is naturally slow to take such stringent steps, which would perhaps more deeply affect it than the other nations mentioned, since Great Britain does the larger trade in American potatoes. In reply to Mr. Herbert, M. P. for Kerry, who recently asked the Chief Secretary for Ireland whether Her Majesty's government had taken any steps to prevent the introduction of the insect, Sir M. M. Beach sought to abate fear, rather underrated the danger, and wisely concluded that any interference with the trade should first have the most careful consideration. Those who have watched the insect's gradual spread during the past seventeen or eighteen years, from its native Rocky Mountain home to the Atlantic, and have seen how the lakes, instead of hindering its march into Canada, really accelerated that march, by affording carriage on vessels, rafters and other floating objects, can have no doubt that the danger felt by our transatlantic friends is real.

Yet I must repeat the opinion expressed a year ago—and which has been very generally coincided in by all who have any familiarity with the insect's economy—that if it ever gets to Europe it will most likely be carried there in the perfect beetle state on some vessel plying between the two continents. While the beetle, especially in the non-growing season, will live for months without food, the larva would perish in a few days without fresh potato tops, and would, I believe,

starve to death in the midst of a barrel of potatoes, even if it could get there without being crushed; for while it so voraciously devours the leaves it will not touch the tubers. The eggs, which are quite soft and easily crushed, could, of course, only be carried over on the haulm or on the living plant; and while there is a bare possibility of the insect's transmission in this way, there is little probability of it since the plants are not objects of commercial exchange, and the haulm, on account of its liability to rot, is not, so far as I can learn, used to any extent in packing. Besides, potatoes are mostly exported during that part of the year when there are neither eggs, larvæ nor potato vines in existence in the United States. There is only one other possible way of transmission, and that is in sufficiently large lumps of earth, either as larva, pupa or beetle. Now, if the American dealers be required to carefully avoid the use of the haulm or shaw and to ship none but clean potatoes, as free as possible from earth, the insect's transmission among the tubers will be rendered impossible; and when such precautions are so easily taken, there can be no advantage in the absolute prohibition of the traffic in American potatoes. As well prohibit traffic in a dozen other commodities, in many of which the insect is as likely to be taken over, as in potatoes, and in some of which it is even more likely to be transported. The course recently adopted by the German government in accordance with the suggestion made in my last report, is much more rational and will prove a much better safeguard: It is to furnish vessels plying between the two countries with cards giving illustrated descriptions of the insect in all stages, with the request that passengers and crew destroy any stray specimens that may be found. Let England and Ireland, together with the other European governments, co-operate with Germany in this plan, and have such a card posted in the warehouses of seaport towns, and the meeting rooms of agricultural societies; and a possible evil will be much more likely avoided. Some of the English journals are discussing the question as to whether, with the more moist and cool climate of that country, our 10-lined potato beetle would thrive there, even if imported. There cannot be much doubt that the insect will rather enjoy the more temperate clime; for while it thrives best during comparatively dry seasons, both excessive heat and drouth as well as excessive wet are prejudicial to it.

It is argued by others that on the continent of Europe our Doryphora would not thrive if introduced, and in a recent letter received from M. Oswald de Kerchove, of Gand, Belgium, author of an interesting pamphlet on the insect,* that gentleman says: "I do not think

* *L'Ennemi de la Pomme de Terre*, etc., Bruxelles, 1875.

that the Doryphora, awakened by our early warm weather, could resist the effects of the late cold which we are apt to have in these European countries." The idea that the climate of North America is less extreme than that of Europe is rather novel to us of the cisatlantic; and from a sufficiently long residence in England, France and Germany, I am decidedly of the opinion that they delude themselves who suppose that Doryphora could not thrive in the greater part of Europe; and that to abandon all precautionary measures against its introduction on such grounds would be the height of folly. An insect which has spread from the high table lands of the Rocky Mountains across the Mississippi Valley to the Atlantic, and that flourishes alike in the States of Minnesota, Wisconsin and Connecticut, and in Maryland, Virginia and Texas—in fact, wherever the potato succeeds—will not likely be discomfited in the potato-growing districts of Europe. Some few, again, have ridiculed the very idea of the insect's passage to Europe in any State, arguing that it is an impossibility for any coleopterous insect to be thus transferred from one country to another. Considering that half the weeds of American agriculture, and a large proportion of her worst insect pests, including two beetles—viz: the Asparagus Beetle (*Crioceris asparagi*,) and the Elm Leaf-beetle (*Galeruca calmariensis*)—in the very same family as our Doryphora, have been imported among us from Europe, there would seem poor foundation for such argument. Moreover, a number of other insects—among them some beetles—of less importance, may be included in the number of importations; and the Rape Butterfly (*Pieris rapæ*,) whose progress westward has been simultaneous with the Doryphora's eastward, and whose importation dates back but a few years, bears witness to the fact that insects more delicate and with fewer chances of safe transport than Doryphora, may succeed in getting alive from one country to the other, and in gaining a foothold in the new home.

The ravages of the insect, bad as they are, very naturally get exaggerated at such a distance from its native home, and the following from the London *Gardener's Chronicle*, gives altogether a too gloomy picture: "When once a field of potatoes has been attacked, all hope of a harvest must be given up; in a few days it is changed into an arid waste—a mere mass of dried stalks." It should not be forgotten that the American farmer by means of intelligence and a little Paris Green is pretty much master of the Doryphora.

One of the most amusing things growing out of the European agitation about this insect that has come to my notice, occurred in our own city of St. Louis. Our worthy Mayor Brown was importuned by a Belgian official for information about the insect, when, instead

of ascertaining the facts, which he might easily have done, either from myself or from any of his bucolic friends, he chose to display his agrestic proficiency by publishing a reply in the daily papers. The following extract from the reply will show that a man may be a good mayor and yet cut a sorry figure as agriculturist or entomologist; for every reader of these reports will notice that there is scarcely a statement that is not opposed to the facts:

> Treating your letter, therefore, seriously, I have to state that there never has been a potato bug seen flying about St. Louis or any other city in the United States or territories; that the potato bug never has caused any alarm in any city nor in the country—only in certain seasons that seemed to be favorable to the production of them. I am not aware of the potato bug attacking any other vegetable. I consider the fears of the people of Belgium entirely groundless, even if the ravages of the potato bug had been great in any locality the past season (which it has not,) and is a matter of no apprehension or comment at the present time in this country.

Mayor Brown, though he has the reputation of being extremely versatile, has evidently not worked in a potato patch of late years! Nor did his letter seem to inspire much confidence among the Belgians, who, soon after its publication, passed an act prohibiting the importation of American potatoes.

IS IT POISONOUS?

This question, which was very fully discussed, pro and con, between the years 1866 and 1870, and settled in the affirmative, has been revived again by Prof. T. J. Burrill, of the Illinois Industrial University, who published an item, which went the rounds of the agricultural press, to the effect that the insect is not poisonous; a statement he supported by the facts that he had rubbed the juice from the mashed insect into a flesh cut, and had had some accidentally squirted into his eye, without any injurious effects resulting. Now I would not go to the extent of a certain sarcastic Chicago professor who affirms that he could fix up a decoction from the dead beetles that would cause a vacancy in the chair of Vegetable Physiology and Horticulture in the Illinois Industrial University, if Prof. Burrill inhaled it, and suggests that there are certain animals that poison will not affect, and that Prof. B. may be one of them; nor to the extreme of a Philadelphia physician who asserts that the tincture from this beetle is the most virulent of insect poisons, and that nothing can be compared with it except the Argas of Miana, in Persia, and the Coya in the valley Neyba, in Popayan, South America, according to Ulloa's Travels, Vol. I, p. 343.* Yet there are so many authenticated cases of poisoning

* See an article in the Transactions of the Homœpathic Medical Society of the State of New York, Vol. VIII, pp. 142-169, 1869, by E. M. Hale, M. D., of Chicago. In this article, which is mostly a quotation from the *American Entomologist*, with four poorly-colored lithographic plates made mostly from my wood-cuts, without credit, Dr. Hale brings together several well authenticated cases of poisoning.

by the fumes from the scalded insects, that it is surprising that Prof. Burrill should have so stoutly assumed the negative of the question without further research and experiment. It is as if I, who am not affected by poison ivy or bee sting, should insist on the harmlessness of either, in the face of their well known poisonous qualities, and their danger to many persons. I know of physicians who persist in disbelieving that death was ever caused by calubrine poison because they have never known a fatal case of snake-bite in their own experience; but skepticism of that which is outside one's own experience usually dwells most where that experience is limited. Since my acquaintance with the Colorado Potato-beetle, three cases of its poisonous influence have been reported to me by persons in whose judgment and veracity I have the utmost confidence,* and without for a moment doubting the facts Prof. Burrill has recorded, which are valuable as far as they go, I would simply say that they do not go far enough, and he has not solved the whole truth of the matter. That the juices of the mashed insects on the human skin are, as a rule, harmless, is proven by the hosts of farmers who have crushed them by hand, and I can testify to the fact from my own experience; indeed, scarcely any one who has had experience believes the wild stories of the poisonous nature of these juices. Yet the rule is not without exceptions, and I do not doubt that, with blood in certain bad conditions, persons have been poisoned by getting said juices into wounds or cuts. But the cases of undoubted poisoning from this insect—cases that have in some instances been serious and even proved fatal—are not from the juices of the body, but from the *bruising* or crushing of large masses, especially by burning or scalding large quantities at a time. The poison seems to be of a very volatile nature, and to produce swelling,

* Even since this was written, and just as this Report is going to press, the following letter, under date of March 15, 1875, came to hand: "On June 1st, 1874, I was called to see a little boy, son of Mr. E. H. Torgis, residing in a little village about two miles from this city. I found the child unwilling to speak, with jactitation, quick breathing, florid condition of the skin, spitting viscid, frothy phlegm; at times a quick, rather rapid pulse, and shortly after my arrival a peculiar spasm. The case was puzzling to me, but that it was a case of poisoning from some source suggested itself at once. I made diligent inquiry into the case, and eventually the father described to me the manner in which the boy would gather his apron full of potato bugs and sit down by a flat stone and by the means of another stone would mash them one at a time. Of course, in so doing he inhaled the volatile properties of the insects' juices. The case was antidoted by the proper antidotes for such a case with marked results. On my second visit made in the evening, I found the face the same in appearance, but the temperature of the skin markedly different; the jaws were slightly relaxed and there was high fever. I then paid some attention to these symptoms, and after making three more visits discharged the case. Another case came to my notice. It was that of a farmer's wife who was in the habit of daily gathering the bugs and scalding or burning them. She was seized with swelling in the hands, burning in the stomach and distension of the abdomen. I attributed it to the same cause, and relieved it accordingly. I also saw two other cases somewhat similar, and from these observations am most thoroughly convinced that the insect is poisonous. J. H. FISHBURNE, M. D.

LOCK HAVEN, PA.

pain and nausea very much as other animal poisons do, and Dr. C. Ruden, of Joliet, Ill., who, as quoted by Dr. Hale (*loc. cit.*, p. 103), experimented on himself by taking the saturated tincture internally —increasing the dose daily from two to twenty drops—experienced great disturbance of the bowels, swelling of the extremities, bloated face, protruding eyes, fever, great thirst and desire for something acid.

From the present state of the case, therefore, while there can be little danger in the cautious killing of the insect in the field, I would not advise recklessness in handling it in large quantities; and we should especially guard against collecting and destroying it by scalding or burning in such quantities. There is no longer any occasion for thus collecting and destroying the insects; and since the custom of tackling the enemy with the Paris Green mixture came into vogue, we have heard much less of potato bug poisoning.

THE USE OF PARIS GREEN.

The question as to the safety and advisability of the use of this mineral in counteracting the ravages of the Colorado Potato-beetle and of other noxious insects, was revived during the year by the reading of a paper before the National Academy of Science, by Dr. J. L. LeConte, of Philadelphia, "On the use of mineral poisons for the protection of Agriculture." After some introductory remarks the paper closed with the following passages:

But in the interests of those to come after us, and for whom, rather than for ourselves, we wish to preserve the results of our labors, I do solemnly protest against the loose manner in which, on the recommendation of persons who have observed only the effects of these poisons upon the insect pests to which their attention has been directed, a most dangerous substance has been placed in the hands of a large mass of uneducated men. You will learn from those who will supplement these remarks the fearful extent to which the manufacture of this poison has increased upon agricultural demand. I can say, on the authority of a friend residing in one of the great agricultural centers of the West, that the druggists of his town order it by the ton.

The ravages of the Colorado Potato-beetle, which has been the chief agent in introducing Paris Green into agriculture, commenced in the West many years ago, and its extension, at a regular rate, was predicted by entomologists, whose opinion was worthy to be received.

The prediction has been verified almost to a year.

Now it was within the power of the Government, through a properly organized scientific bureau for the protection of agriculture, to have ordered a commission, who would, after thoroughly investigating the subject, recommend proper measures to be adopted. I am free to say that the use of metallic poisons would not be one of them. But human labor, properly compensated and intelligently employed to avert a national calamity, such as has come upon us from the incursion of the insect, might, perhaps, have been one of the agents suggested.

In a discourse before the American Association for the advancement of science, at Portland, Maine, in August, 1873, I recommended, among other measures for the promotion of economic entomology in the United States, the reorganization of the Department of Agriculture on a scientific basis for the proper protection and advancement of agriculture.

This recommendation was made the basis for several efforts on the part of the farmers of the Mississippi Valley. But, as is usual in cases where the emoluments of office and the expenditure of public funds are at stake, the attempt at reform failed. I now appeal—and trust to your influence to give the appeal as wide a circulation as

possible—to the whole of the intelligent community of the country to stop this indiscriminate use of metallic poisons on the soil until the whole subject has been investigated, not by observers of the habits of insects, but by a properly constituted scientific commission of chemists, physiologists and entomologists, who will recommend a general system of attack upon our insect enemies without danger to our future agricultural prosperity.

The food-producers have not been strong enough to effect the much needed reform· Let the food-consumers now unite with them in demanding it.

The paper, which was discussed by several eminent scientists, then and there present, who conjured up all the possible cases of poisoning from Paris Green they could think of, in its careless handling, use in coloring wall paper, etc., provoked the following resolution :

Resolved, That a committee be appointed to investigate and report upon the subject of the use of poisons applied to vegetables or otherwise for the destruction of deleterious insects and other animals, and also the incautious use of poisons in the ornamentation of articles of food and destructive purposes generally, such, for instance, as the coloring of paper.

No one can hold that eminent entomologist, Dr. J. L. LeConte, in higher esteem than does the writer; and so just and to the point do I deem the remarks about our Department of Agriculture that I make place for them in full. Yet the position assumed regarding the use of Paris Green places my friend in the attitude of an alarmist, and subsequent writers, prone to exaggerate, have played upon the tocsin sounded by him till pictures of suffering and death from the use of the mineral; of the earth poisoned with it and sown with danger, are conjured up *ad libitum*. Quoth the Utica (N. Y.) *Herald*: "The eye of science sees the horrible spectre of the demon bug stalking over the patch where its body was struck down by the deadly Paris Green, and laughing in fiendish glee over the terrible retribution that awaits its slayer. * * * The chemical possibilities which may result in the poisoning of the vegetation raised from the poisoned soil are fearful to contemplate!" While, therefore, Dr. LeConte's object—which was evidently to cause more thorough experiments and investigations to be made than had hitherto been made—was praiseworthy enough, I consider the attitude assumed neither commendable nor tenable; first, because it takes no account of an extensive past experience; second, because it is contrary to that experience, and what experiment had already been made.

The subject is one of vast importance, and as it was my lot to be, perhaps, as instrumental as any one in causing the now general use of Paris Green, both for the Colorado Potato-beetle and for the Cotton-worm, I take pleasure in presenting the facts in the case, so far as they are known; for these facts will serve to dissipate much misap-

prehension, and certainly support the opinion previously expressed on the subject in these reports :*

PAST EXPERIENCE.—In the early history of the use of this mineral as an insecticide, most persons, myself included, were loth, on theoretical grounds, to recommend its general use ; and I have ever insisted that the many other mechanical and preventive measures, which, if persistently employed, are sufficient to defeat the foe, should be resorted to in preference. But the more diluted form and improved methods now-a-days employed in using the poison, render it a much safer remedy than it was a few years back; and no one should fail to take into account that during the past six years millions of bushels of potatoes have been raised, the leaves of which have been most thoroughly sprinkled with the Paris Green mixture, without any injurious effect to the tuber, or to persons using potatoes raised in this manner. Indeed, scarcely any potatoes have been raised in the Middle States during these years, without its use; yet I have to learn of the first authentic case of poisoning or injury whatever, except through carelessness and exposure to its direct influence. So far as experience

* We hear many fears expressed that this poison may be washed into the soil, absorbed by the rootlets, and thus poison the tubers; but persons who entertain such fears forget that they themselves often apply to the ground, as nourishment for the vines, either animal, vegetable or mineral substances that are nauseous, or even poisonous to us. Animal and vegetable substances, of whatsoever nature, must be essentially changed in character and rendered harmless before they can be converted into healthy tubers, and a mineral poison could only do harm by being taken with the potatoes to the table. That any substance, sprinkled either on the vines or on the ground, would ever accompany to the table a vegetable which develops underground, and which is always well cooked before use, is rendered highly improbable. There can be no danger in the use of sound tubers. But the wise and well-informed cultivator will seldom need to have recourse to Paris Green, as he will find it more profitable to use the different preventive measures that have, from time to time, been recommended in these columns.

The poison may do harm, however, by being carelessly used, and it is most safely applied when attached to the end of a stick several feet long, and should not be used where children are likely to play.—[3d Rep., pp. 99-100.

Some persons have even imagined that potatoes grown on land where it has been used are often watery, rank and of bad flavor, and according to the Monthly Report from the Department of Agriculture for August and September last, peas planted in soil mixed with the green rotted immediately and would not germinate, while those in unadulterated soil grew finely and flourished, but died immediately when transplanted into the soil mixed with the Green. How far these statements are to be relied on, each one must judge for himself, but it is certainly advisable to avoid as much as possible the use of the poison, by carrying out the other methods, both preventive and remedial, advocated in previous Reports; for wholesale remedies always have the disadvantage of destroying some friends with the foes, and in this case the true parasites and those cannibals which by mastication partake bodily of their green-covered prey, certainly fall in the general slaughter. But this remedy has now been so extensively used with good results and without any apparent harm to the tubers, that full and thorough proof against it will be necessary to cause its abandonment. Properly mixed I have used it without the slightest trace of evil effect on the leaves or tubers, and I know hundreds of others who have done likewise; so that with present experience I should not hesitate to recommend its judicious use. What is wanted on this subject, is a long series of thoroughly accurate and reliable experiments. Let our Agricultural Colleges make them! Meanwhile Paris Green will be extensively used, especially while the vines are young and most need protection; for after the expense of preparing the land and planting has been incurred, it will not do to get discouraged and abandon the field to the enemy, when such an efficient remedy is at hand.—[4th Rep., pp. 11-12.

goes, therefore, there is nothing to fear from the judicious use of the mineral. Let us then consider, from the best authority, what are the effects of its use as at present recommended: First, on the plant itself; second, on the soil; third, on man, indirectly, either through the soil or through the plant.

Its Influence on the Plant.—Practically the effect of sprinkling a plant with Paris Green, will depend very much on the amount used and on the character of the plant treated. Thus, from experiments which I made in 1872, a thorough coating of a mixture of one part of Green to fifteen of flour, while injuring some of the leaves of peas, clover and sassafras, had no injurious effect on young oaks, maples and hickories, or on cabbage and strawberries; while the fact has long been known that when used too strong and copiously it destroys potato vines. It is for this reason that the experiments made during the past year on beets, by a committee appointed by the Potomac Fruit Grower's Society, are of little value, as against the universal experience of the farmers of the Mississippi Valley. The mixture used by the committee, and which they call "highly diluted," consisted of one part of Green with but six of the dilutent, instead of from twenty-five to thirty parts of the latter; and it is no wonder that, as reported by the committee, the vitality of the plants was seriously impaired. There can be no question, therefore, about the injurious effect of the Green upon potato vines, when it is used pure or but slightly diluted; yet in this case, since it is the office of the leaves to expire rather than inspire, we cannot say that the plant is injured, or killed by absorption, any more than if it were injured or killed by hot water, which, according to the degree to which it is heated, or the copiousness of the application, may either be used with impunity or with fatal effects. Indeed, judging from my own experience, I very much incline to believe that future careful experiments will show that injury to the leaf by the application of this compound, arises more often from the stoppage of the stoma, which is effected as much by the dilutent as by the arsenite itself. So much for the influence of the poison when coming in contact with the plant above ground. The question as to how it affects the plant below ground, through the roots, may be considered in connection with—

Its Influence on the Soil.—As Prof. J. W. Johnson, in an admirable review of this subject, has recently stated:* "One pound of pure Paris Green contains about ten ounces of white arsenic, and about four ounces of copper;" or, to state it in the usual way, Sweinfurt or *pure* Paris Green contains fifty-eight per cent. of arsenious

* New York Weekly Tribune, December 16, 1874.

acid. One pound of the Green uniformly spread over an acre of soil, would amount to sixteen-hundredths of a grain per square foot, or nine-hundredths of a grain of arsenious acid. If uniformly mixed with the soil to the depth of a foot, it would, of course, be the same to the cubic foot. In actual practice, even this amount does not reach the soil direct or in an unchanged form, since much of it is acted upon by the digestive organs of the fated insects. It is safe to say that even if the Green retained for all time its poisonous power and purity in the soil, this mere fractional part of a grain might be added annually for half a century without any serious effects to the plants. In reality, however, there is no reason to believe that it does so remain. Of the few experiments on record which bear on this point, those made by Prof. W. K. Kedzie, while connected with the Michigan Agricultural College, in 1872, are the most interesting and instructive. In a paper read before the Natural History Society of the College, he proved, from these experiments, that where water was charged with carbonic acid or ammonia, a certain portion of the Green was dissolved, but was quickly converted into an insoluble and harmless precipitate with the oxide of iron which exists very generally in soils. Fleck has shown (Zeitschrift für Biologie, Bd. viii, s. 455, 1872) that arsenious acid in contact with moist organic substances, especially starch sizing, forms arseniuretted hydrogen, which diffuses in the air; and it is more than probable that the Green used in our fields will lose its poisonous power, and disappear in these and other ways. The question as to how the plant is affected by the poison through the soil is, therefore, partly answered by the above facts. Water is both the universal solvent and the vehicle by which all plants appropriate their nourishment; but in this instance its solvent and carrying power is for the most part neutralized by the oxide of iron in the soil; and though some experiments by Dr. E. W. Davy, and quoted by Prof. Johnson in the article already cited, would indicate that, under certain circumstances, some of the arsenious acid may be taken up by plants before passing into the insoluble combination ; yet the quantity is evidently very slight.

Some persons have imagined that the soggy and watery potatoes that have been so common of late years are due to the influence of this poison ; but this idea is proved to be erroneous by the fact that such imperfect potatoes are not confined to the districts where Paris Green has been used. Indeed, they are much more likely due to the injury and defoliation of the plant by the insect; for no plant can mature a healthy root when its leaf system is so seriously impaired by the constant gnawings of insects. Finally, we must not forget that both arsenic and copper are widely distributed throughout the inor-

ganic world* and are found naturally in many plants; and so far from injuring plants, in minute quantities, arsenic occurs in the best superphosphates and the volcanic soil around Naples, which, like all volcanic soils, contains an unusual amount of it, has the reputation of being a specific against fungoid diseases in plants. A certain quantity may therefore be beneficial to plants, as it appears to be to animals, since horses fed on a grain or two a day are said to thrive and grow fat.†

ITS INFLUENCE ON MAN INDIRECTLY THROUGH THE SOIL OR THROUGH THE PLANT.—The Green as now used could not well collect in sufficient quantities to be directly deleterious to man in the field in any imaginable way; while its injury through the plant is, I think, out of the question; for the plant could not absorb enough without being killed. The idea that the earth is being sown with death by those who fight the Colorado Potato-beetle with this mineral, may, therefore, be dismissed as a pure phantasmagoria.

In conclusion, while no one denies the danger attending the careless use of Paris Green, and all who have recommended its use have not hesitated to caution against such carelessness, a careful inquiry into the facts from the experimental side bears out the results of a long and extensive experience among the farmers of the country—viz: that there is no present or future danger from its judicious use, in the diluted form, whether as liquid or powder, in which it is now universally recommended. Nor is the wholesale charge made by Dr. LeConte that the remedy has been recommended by persons who have observed only the effects of the poison on the insects to which their attention has been directed, warranted by the facts. It is in this as in so many other things, a proper use of the poison has proved, and will prove in future, a great blessing to the country, where its abuse can only be followed by evil consequences. Poison is only a relative term and that which is most virulent in large quantities is oftentimes harmless or even beneficial to animal economy in smaller amounts. The farmers will look forward with intense interest to the work of the committee appointed by the National Academy, or of any national commission appointed to investigate the subject, and will hail with

* Prof. Johnson, (*loc. cit.*) writes:

The wide distribution of both arsenic and copper is well known to mineralogists and chemists. These metals are dissolved in the waters of many famous mineral springs, as those of Vichy and Wiesbaden. Prof. Hardin found in the Rockbridge Alum Springs of Virginia, arsenic, antimony, lead, copper, zinc, cobalt, nickel, manganese, and iron. The arsenic, however, was present in exceedingly minute quantity. Even river water, as that of the Nile, contains an appreciable quantity of arsenic. Dr. Will, the successor of Liebig at Giessen, proved the existence of five poisonous metals in the water of the celebrated mineral springs of Rippoldsau, in Baden. In the Joseph's Spring he found to 10,000,000 parts of water arsenic (white,) 6 parts; tin oxide, 1-4 part; antimony oxide, 1-6 part; lead oxide, 1-4 part; copper oxide, 1 part. Arsenic and copper have been found in a multitude of iron ores, in the sediments from chalybeate springs, in clays, marls and cultivated soils. But we do not hear that the arsenic thus widely distributed in waters and soils ever accumulates in plant or animal to a deleterious extent.

† See an article on "Arsenic in Agricultural and Technical Products," by Prof. A. Vogel, in *Scientific American*, Oct. 17, 1874.

joy and gratitude any less dangerous remedy that will prove as effectual; but until such is discovered, they will continue to use that which has saved them so much labor and given so much satisfaction. I would therefore say to those agriculturists of the East who are in any way alarmed by what has been written on this subject, and who hesitate to use the Paris Green mixture—profit by the experience of your more western brethren, and do not allow the voracious Doryphora to destroy your potatoes, when so simple and cheap a remedy is at hand!

THE BEETLE EATS AS WELL AS THE LARVA.

As the statement has been quite frequently made during the year, in Eastern papers, that the beetle does not feed, and that consequently there is nothing to fear from them early in the year, the fact may as well be reiterated that the beetle does feed, though not quite so ravenously as the larva. But as they are on hand as soon as the young plants peep through the ground, and as these first spring beetles are the source of all the trouble that follows later in the season, it is very important to seek and destroy them.

IT PASSES THE WINTER IN THE BEETLE STATE.

The statement is continually made that the insect hibernates as a larva. "I must insist that with us it never does, but that the last brood invariably hibernates in the perfect beetle state. Specimens have been found at a depth of eight and even ten feet below the surface, but the great majority do not descend beyond eighteen or twenty inches, and many will not enter the ground at all if they can find other substances above ground that will shelter them sufficiently. The beetles are found abundantly above the ground in the month of April in the latitude of St. Louis, but often re-enter it after they have once left, especially during cold, damp weather."—[4th Report.

NEW FOOD PLANTS.

Mr. A. W. Hoffmeister, of Ft. Madison, Iowa, an entomologist, the accuracy of whose observations may be relied on, writes:

Last year, after all the early potatoes had been taken up and the late ones either wilted through excessive dryness or eaten up by the Colorado gentleman, I was astonished to find so many 10-lined spearmen in the lower part of town, while in the upper part they were reasonably scarce; but I was more astonished to find that the larvæ had stripped the *Verbascum* of its leaves.

The Mullein, belonging to the Figwort family, must therefore be added to the list of plants on which the insect lives and flourishes. An item went the rounds of the papers during the year to the effect that

alfalfa is greedily devoured by this insect, but just how much credit should be given to the statement, which originated with a Montana correspondent of the *Farmer's Home Journal* of Kentucky, it is difficult to say. Probably the reference was originally made to the old-fashioned "potato-bugs," or blister-beetles, which are common in the Western country and very general feeders.

NEW MEANS OF DESTRUCTION.

The use of Paris Green having become a universal remedy for this pest, there is little to be said under this head, except as regards the improved methods of using the application. Last spring, Mr. Frank M. Gray of Jefferson, Cook county, Ills., sent me a sprinkler which he has constructed for sprinkling two rows at once. It is so simple and yet so useful that a brief description of it will not be out of place here. It consists of a can capable of holding about eight gallons of liquid, and so formed as to rest easily on the back, to which it is fastened, knapsack fashion, by adjustable straps, which reach over the shoulders and fasten across the breast. To the lower part of the can are attached two rubber tubes which are connected with two nozzles on sprinklers. The inside of the can has three shelves which help to keep the mixture stirred. There is a convenient lever at the bottom which presses the tubes and shuts off the outflow at will, and two hooks on the sides near the top on which to hang the tubes when not in use. On the top is a small air-tube and a capped orifice. Two bucketfulls of water are first poured into the can, then three tablespoonfulls of good Green, well mixed with another half-bucketfull of water and strained through a funnel-shaped strainer which accompanies the machine, and the use of which prevents the larger particles of the Green from getting into the can and clogging up the sprinklers. Five to eight acres a day can readily be sprinkled by one man using the can, and from one to one and a half pounds of good Green, according to the size of the plants

[Fig. 1.]

Gray's Improved Sprinkler, for the use of Paris Green water.

will suffice to the acre. Two lengths of nozzles are furnished, one for use when the plants are small, the other when they are larger. The can should be filled on the ground and then raised on a bench or barrel, from which it is easily attached to the back. The walking serves to keep the Green well shaken, and the flow of liquid is regulated at will by a pressure of the fingers at the junction of the tubes with the metallic nozzles. When not in use, the tubes should be removed and the can emptied and laid on its back. I can testify to the ease and efficiency with which this little machine may be used, and it has been so well thought of that it is now manufactured and for sale at 66 W. Madison street, Chicago, though I do not know at what price.

THE PROPER SCIENTIFIC NAME OF THE BEETLE.

Of course the American reader need not be informed of the fact that this insect has been universally known, since it attained popular notoriety, by the scientific name of *Doryphora* 10-*lineata* Say. American coleopterists have from the first been fully aware that it differed from the typical genus *Doryphora* in lacking the point produced on the mesosternum (middle of breast), which is characteristic of that genus as defined by its founder, Olivier. Yet as this character is of secondary importance, and by no means of generic value, in many other families of Coleoptera; and our insect in other characters, and especially in the short and transverse form of the maxillary palpi, approaches nearer to the genus *Doryphora* than to any other genus of its sub-family (*Chrysomelides*), that father of American Entomology, Thomas Say, described it under that genus. Subsequent American authorities, including Dr. LeConte, have followed this enlarged definition of the genus *Doryphora*, considering the palpial of much more value than the sternal characters; and Say's name has consequently been universally adopted in this country both by popular and technical writers. The genus *Chrysomela* of Linnæus has been made the basis of several minor divisions, which are considered to be of generic value or not, according to the opinions of different systematists. Thus Melsheimer in his catalogue of N. A. Coleoptera (1853) refers our potato-beetle to the genus *Polygramma* erected by the French entomologist Chevrolat upon unimportant colorational characters. Recently, the Sweedish entomologist Stäl in a Monograph of the American Chrysomelides* erects the genus *Myocoryna*, on the slightly compressed form of the antennal club, for our potato beetle, and several other species from Texas and Mexico. Until some yet distant day when the science of entomology shall be perfected, there will be

* Trans. Sweedish Academy, 1858, p. 316.

a constant chopping and changing in generic nomenclature (much of it of questionable warrant or advantage), and it is ofttimes preferable, especially in popular works, to anchor to the more comprehensive and better known generic terms, instead of confounding the reader by the more recent changes. There is nothing to prevent any author from erecting new genera, but whether a proposed genus is in the end by common consent adopted or not will depend on the value of the characters on which it is founded. Our best authorities ignore the more recent divisions, and LeConte writes me: "Let us set our faces against the adoption of the multitude of genera, which even the founders fail to sustain. * * * Let *Polygramma*, *Leptinotarsa*, *Myocoryna*,* etc., never be mentioned amongst us." Thence, if we write *Chrysomela* 10-*lineata* (Say), with Crotch, in his list of N. A. Coleoptera (1873), we indicate that in our opinion the later divisions into which that genus has been broken up, and which would include this species, are not based on sufficiently important and distinctive characters; if we write *Doryphora* 10-*lineata* Say, we express our belief in the generic value of the palpial characters. In either event no confusion will ensue providing the authority for the species is given, and the American entomologist does no violence either to good sense or propriety by designating the insect as it was at first described, i. e., *Doryphora* 10-*lineata*. It is because of the present unsettled conditon of entomological nomenclature that the custom yet prevails of attaching the abbreviated authority to the names of insects, as the only sure way to express our meaning and obviate all confusion as to the species intended.

I have been led to these synonymical remarks by an article by M. E. A. Carrière, which, had it occurred in a less important journal than the *Revue Horticole*,† of which he is editor, would not deserve notice. With an arrogance in keeping with the superficial knowledge of the subject he displays, M. Carrière undertakes to read the Americans an entomological lesson, teach them how to correctly designate this potato enemy and "cut short the confusion" which he takes it for granted exists on the subject in this country. As the idea is altogether too prevalent among European writers that American naturalists are a set of know-nothings, I shall briefly notice this article of M. Carrière's to show how ridiculously pragmatical he appears in

* Even if the characters given by Stål are ever considered by authors generally of generic value, the name *Myocoryna* could not be employed, as it is preoccupied by a genus, in the same family of Chrysomelians, founded by Dejean (Cat. 3d edit., p. 428); and if our potato-beetle is to be known by any subgeneric title I would propose that of *Thlibocoryna*.

† Subsequently noticed in several European periodicals, and republished in the *Journal d' Agriculture Pratique*, and in the Bulletin of the *Soc. Centrale d' Agr. du Dep. de l' Hérault*, 1874, pp. 84-5.

the eyes of those whom he attempts to teach, however much his show of erudition may awe his French readers.

First, then, we are informed that our insect should be referred to the genus *Chrysomela*, or else—admitting the subdivisions of that genus—to the sub-genus *Polygramma* of Chevrolat. Considering that before M. Carrière wrote, Crotch had made the former reference, and Melsheimer many years previously, the second—this information is not novel.

Secondly, we are gravely told that another error "more difficult to comprehend, because it is pure nonsense," consists in calling the insect by the specific name of *decempunctata!* Since no American entomologist has ever called it by that name, and it was first so designated in a foreign journal, by mistake, M. Carrière might have saved himself the exhaustive effort to comprehend it.

Thirdly, M. Carrière considers the *juncta* of Germar as a synonym of 10-*lineata* Say, a thing which no entomologist at all informed would think of doing to-day, after the characters of the two have been so well defined in this country.

Fourthly, he undertakes to define this amalgamated species, and does it in so bungling a way that only general characters are given, and the most distinctive features omitted. Yet with complacency he speaks of this definition as "these details which we have deemed necessary to particularize and firmly establish the identity and the character of *C. decemlineata!!*"

Fifthly, we are gravely informed that our beetle is not a fly (*mouche*)—most interesting information, since no one in America calls it a "fly."

Sixthly, we are told that *Colorado* is the vulgar name for the insect—a statement which shows that its author is as good a geographer as he is entomologist. He then declares that no remedy has been discovered "for that which is employed is no less redoubtable than the evil itself;" ridicules (as do all who have no proper knowledge of the important part played by parasitic and predaceous insects in keeping the vegetable feeders in check) the idea of benefit to man from predaceous insects; and closes by recommending certain remedies, which have been proved useless here and are the conceptions of inexperience.

Such are some of the more glaring errors in this production of a gentleman who plays the role of instructor to the American entomologists. In short, instead of deriving his information from trustworthy sources, and ascertaining what had really been written by Americans on this subject, as every cautious critic would have done, M. Carrière gets all he possessed at second hand from the poor translations, in cer-

tain London journals, of Col. F. Hecker's communication to the *Gartenlaube*, which I referred to in my Sixth Report (p. 15). He thus lances his criticisms at imaginary errors, and in attempting to be deep becomes extremely shallow.

THE CHINCH BUG—*Micropus leucopterus* (Say).

(Subord. HETEROPTERA; Fam. LYGÆIDÆ.)

Never, perhaps, in the history of the country, and certainly never in the history of the State of Missouri, was the Chinch Bug so disastrous in its work as during the year 1874. This fact is explained in part by the very dry weather which prevailed during early summer in the Northwestern States—weather favorable to the insect's well-being and multiplication—but was also greatly due to the very dry Fall of 1873 and the following comparatively mild and dry Winter; conditions that permitted the survival of an unusually large number of the bugs, which dispersed over our fields in the spring and gave birth to myriad young, which throve and prospered amazingly. In order to gather as complete statistics as possible about this insect in Missouri, I sent the following questions to several prominent farmers in every county in the State:

1. How far back in the history of your county has this insect (the Chinch Bug) been known to injure the grain and grass crops?

2. What crops have suffered most from its ravages?

3. Have any systematic efforts ever been made to overcome its injuries; and have you any idea to what extent my Second Report—which contained what was known about the insect up to that time, and which was bound in with the Fifth (1869) State Agricultural Report—is distributed or known of among the farmers of your county?

4. Give approximately this year's estimated damage in your county, by this single insect—all crops affected by it considered.

Replies to these questions have been received from nearly every county, and I am under obligations to the many gentlemen throughout the State who have thus assisted me. To publish these replies in full would occupy altogether too much space, and would be unnecessary; yet, as there is much valuable experience contained in them, I have brought together such parts as will most generally interest the farmers of the State, in an Appendix at the end of this article.

It will be seen that the replies to the third question are almost unanimous to the effect that little or nothing is known or has been seen of the Second Entomological Report; and it is for this reason and from the number of letters of inquiry about the insect that reached me about harvest time last Summer, that I deem it advisable to give a full account of the Chinch Bug in the present volume, repro-

ducing, in quotation marks, portions of the article referred to in the Second Report.

APPEARANCE AND TRANSFORMATIONS OF THE CHINCH BUG.

[Fig. 2.]

CHINCH BUG: Hair line underneath showing natural size.

Few farmers in this section of the country need an introduction to this insect; but lest there be those who are so blessed as not to know the gentleman by sight, I annex his portrait. Known to science as *Micropus leucopterus*, he belongs to the Half-wing Bugs (*Heteroptera*,) the same sub-order to which a well known bed pest belongs, and he exhales the same most disagreeable odor. He subsists by sucking with his sharp pointed beak (Fig. 3, *i*) the grasses and cereals, thereby causing them to shrink, wilt and wither—and not by biting their substance as many persons suppose. Like the other species of its sub-order, it undergoes no very sudden transformations. Born as a little pale yellow 6-legged atom, scarcely visible to the naked eye, and with a tinge of red near the middle of the body, (Fig. 3, *c*,) it goes through four molts before acquiring wings. It is bright red, with a pale band across the middle of the body after the first; somewhat darker with the merest rudiments of wing-pads after the second, and quite brown, with distinct wing-pads, but with the pale transverse band still visible, after the third, in which it assumes the pupa state, and from which, in the fourth molt, it escapes as a winged bug.

[Fig. 3.]

IMMATURE STAGES OF CHINCH BUG:—*a*, *b*, eggs; *c*, newly-hatched larva; *d*, its tarsus; *e*, larva after first molt; *f*, same after second molt; *g*, pupa—the natural sizes indicated at sides; *h*, enlarged leg of perfect bug; *j*, tarsus of same still more enlarged; *i*, proboscis or beak, enlarged.

[Fig. 4.]

SHORT-WINGED CHINCH BUG.

"There are, as is well known to entomologists, many genera of the Half-winged Bugs, which in Europe occur in two distinct or "dimorphous" forms, with no intermediate grades between the two; namely, a short-winged or sometimes even a completely wingless type and a long-winged type. Frequently the two occur promiscuously together, and are found promiscuously copulating so that they cannot posibly be distinct species. Sometimes the long-winged type occurs in particular seasons, and espe-

cially in very hot seasons. More rarely the short-winged type occurs in a different locality from the long-winged type, and usually in that case in a more northerly locality. We have a good illustration of this latter peculiarity in the case of the Chinch Bug, for a dimorphous short-winged form occurs in Canada, and Dr. Fitch describes it from specimens received from the States, as a variety, under the name of *apterus*."

DESCRIPTIVE.

MICROPUS LEUCOPTERUS (Say.)—*Egg*—Average length 0.03 inch, elongate-oval, the diameter scarcely 1-5 the length. The top squarely docked and surmounted with four small rounded tubercles near the center. Color, when newly laid, pale or whitish, and translucent, acquiring with age an amber color, and finally showing the red parts of the embryo, and especially the eyes toward tubercled end. The size increases somewhat after deposition, and will sometimes reach near 0.04 inch in length.*

Larval Stages.—The newly hatched larva is pale yellow, with simply an orange stain on the middle of the three larger abdominal joints. The form scarcely differs from that of the mature bug, being but slightly more elongate; but the tarsi have but two joints (Fig. 4, *d*,) and the head is relatively broader and more rounded, while the joints of body are sub-equal, the prothoracic joint being but slightly longer than any of the rest. The red color soon pervades the whole body, except the first two abdominal joints, which remain yellowish, and the members, which remain pale. *After the first molt* the red is quite bright vermillion, contrasting strongly with the pale band across the middle of the body, the prothoracic joint is relatively longer, and the metathoracic shorter. The head and prothorax are dusky and coriaceous, and two broad marks on mesothorax, two smaller ones on metathorax, two on the fourth and fifth abdominal sutures, and one at tip of abdomen are generally visible, but sometimes obsolete; the third and fourth joints of antennæ are dusky, but the legs still pale. *After the second molt* the head and thorax are quite dusky, and the abdomen duller red, but the pale transverse band is still distinct; the wing-pads become apparent, the members are more dusky, there is a dark red shade on the fourth and fifth abdominal joint, and, ventrally, a distinct circular dusky spot covering the last three joints.

Pupa—In the pupa all the coriaceous parts are brown-black, the wing-pads extend almost across the two pale abdominal joints which are now more dingy, while the general color of the abdomen is dingy gray; the body above is slightly pubescent, the members are colored as in the mature bug, the three-jointed tarsus is foreshadowed, and the dark horny spots at tip of abdomen, both above and below, are larger.

Imago—The perfect insect has been well described, and I will append the original descriptions:

LYGÆUS LENCOPTERUS (chinch bug). Blackish, hemelytra white with a black spot. Inhabits Virginia.

Body long, blackish, with numerous hairs. Antennæ, rather short hairs; second joint yellowish, longer than the third; ultimate joint rather longer than the second, thickest; thorax tinged with cinereous before, with the basal edge piceous; hemelytra white, with a blackish oval spot on the lateral middle; rostrum and feet honey yellow; thighs a little dilated.

Length less than three-twentieths of an inch.

I took a single specimen on the eastern shore of Virginia.

The whiteness of the hemelytra, in which is a blackish spot strongly contrasted, distinguishes this species readily—[Say, Am. Entomology, I, p. 329.

* This last is the length given by Dr. Shimer. The stricture on this measurement in my 2d Report (p. 22,) first appeared in the *American Entomologist*, in an editorial prepared principally by Mr. Walsh, and was made without having measured the egg.

The above description originally appeared in 1832, in a pamphlet entitled "Descriptions of new species of Heterocerous Hemiptera of N. A."

Length 1¾ lines, or three-twentieths of an inch. Body black, clothed with a very fine grayish down, not distinctly visible to the naked eye; basal joint of the antennæ honey yellow; second joint of the same tipt with black; third and fourth joints black; beak brown; wings and wing-cases white; the latter are black at their insertion, and have near the middle two short irregular black lines, and a conspicuous black marginal spot; legs dark honey yellow, terminal joint of the feet, and the claws black.—[Dr. Wm. LeBaron in the *Prairie Farmer* for September, 1850, vol. x, pp. 280, 281, where the name of *Rhyparochromus devastator* is proposed for it.

Dr. Fitch also enumerates the following varieties of this insect:

a, *immarginatus*. Basal margin of the thorax not edged with yellowish. Common.

b, *dimidiatus*. Basal half of the thorax deep velvety black, anterior half grayish. Common.

c, *fulvivenosus*. The stripes on the wing covers tawny yellow instead of black.

d, *albivenosus*. Wing covers white, without any black marks except the marginal spot. A male.

e, *apterus*. Wingless and the wing covers much shorter than the abdomen.

f, *basalis*. Basal joint of the antennæ dusky and darker than the second.

g, *nigricornis*. Two first joints of the antennæ blackish.

h, *femoratus*. Legs pale livid yellow, the thighs tawny red. Common.

i, *rufipedis*. Legs dark tawny red or reddish brown.

To these varieties, all of which occur with us, I would add one which may be known as *melanosus*, in which the normal white of the wings is quite dusky, and contains additional black marks at base and toward tip, and in which all the members and the body except the rufous hind edge of thorax are jet black.

PAST HISTORY OF THE CHINCH BUG.

"The first record we have of the prevalence of the Chinch Bug was in the old Revolutionary times in North Carolina, where it was confounded with the Hessian Fly, an insect just then imported from Europe into the United States. Ever since those times it has been an epidemic pest, in particular years, in North and South Carolina and in Virginia. The great American entomologist, Thomas Say, in 1831, when he had been residing in Indiana for six years, was the first to name and describe it scientifically. He states that he 'took a single specimen on the Eastern shore of Virginia;' whence we may reasonably infer that it was then either unknown or very rare in Indiana, and probably also in other Western States."

PAST HISTORY OF THE CHINCH BUG IN MISSOURI.

In the Appendix will be found records of this insect as far back as 1836 in two counties in Missouri. W. D. Palson, of Southwest City, McDonald county, writes: "I have been here ever since 1836, and have seen the bugs ever since I could recollect, but never knew what they were until 1873." D. P. Dyer, of Warrenton, Warren county, also speaks of their appearance during the same year. No very serious damage was however done at this time by the insect, and not until 1844 are any complaints made. From this time it gradually increased in numbers, and during the summers of 1854, 55, 56, 57 and 59 did much

damage to all kinds of cereals and grasses. In 1866 they were quite bad and also in 1870 and 1871, while during the dry years of 1872 and 1873, they spread pretty much all over the State and were injurious in counties like Scott, Greene and Mississippi, where they had scarcely been noticed before.

"We may safely conclude that the Chinch Bug has always existed in Missouri, in small numbers; but that it did not multiply to an injurious extent until the grains began to be cultivated on an extensive scale. At all events, we know from the evidence of Dr. Harris and Dr. Fitch, that it existed long ago in exceedingly small numbers in New York, and even in Massachusetts. What the causes may have been that thinned out the numbers of this insect in former times in the West, is another question. In former times, the great bulk of these bugs were probably destroyed every winter by the prairie fires, and, as cultivation has extended in consequence of the country being gradually settled up, and less and less prairie has been annually burnt over, the number that has survived through the winter to start the next year's broods has annually become greater. If these views be correct, we may expect them, unless more pains be taken to counterwork and destroy them, to become, on the average of years, still more abundant than they now are, whenever prairie fires shall have become an obsolete institution; until at last Western farmers will be compelled, as those of North Carolina have already several times been compelled, to quit growing wheat altogether for a term of years.

"It may be very reasonably asked, why the Chinch Bug does not increase and multiply in Massachusetts and New York, seeing that it existed there long ago, and that there are, of course, no prairie fires in those States to keep it in check. The answer is, that the Chinch Bug is a Southern, not a Northern species; and that hundreds of Southern species of insects, which on the Atlantic seaboard only occur in southerly latitudes, are found in profusion in quite a high latitude in the Valley of the Mississippi. The same law, as has been observed by Professor Baird, holds good both with Birds and with Fishes."*

The Chinch Bug will, also, for reasons which will presently be made apparent, naturally thrive less in the moister climate of the New England States. Again we may very naturally infer that the more cleanly and careful system of culture, and the more general use of the roller in the older States have had much to do with the comparative immunity they enjoy. I am also of the opinion that it will

*Silliman's Journal, XLI, p. 87.

not multiply as much on a sandy as on a clayey loam, for the reason that it cannot move about as readily in such a soil; and the immunity of grain immediately along the Missouri river in Cole county, attested by Mr. N. DeWyl and others, is, I think, more due to the sandy nature of the soil, compared to that farther back of the river, than to the greater moisture in the immediate vicinity of the river.

DESTRUCTIVE POWERS OF THE CHINCH BUG.

Though but one of the many insect pests that afflict the farmer, it is, perhaps, all things considered, the most grievous. Few persons who have not paid especial attention to the subject have any just conception of the amount of damage the Chinch Bug sometimes inflicts, and many will be surprised to learn that, setting aside the injury done to corn, the loss which the little scamp occasioned to the small grains in the Northwestern States in 1871, amounted to upwards of thirty million dollars, at the very lowest estimates—as proved by careful computations made by Dr. LeBaron in his Second Annual Report as State Entomologist of Illinois. The loss in 1874 may safely be put down at double that sum. Indeed, not even the migratory locusts that, from time to time, spread devastation over the western country can be compared in destructiveness to this little bug; for his devastations, though not so general, are more incessant, and cover a more thickly settled range of country. Those who have not seen the ground alive and red with its young, or the plants black with the dark bodies of the more mature individuals; those who have not seen the stout cornstalk bow and wilt in a few hours from the suction of their congregated beaks, or a wheat field in two or three days rendered unfit for the reaper; those who have never seen the insect marching in solid phalanx from field to field, or absolutely filling the air for miles—can form no adequate conception of its destructive powers! It is no wonder, therefore, that Kirby and Spence, more than half a century ago, exclaimed, in speaking of this "chintz-bug-fly," that "it seems very difficult to conceive how an insect that lives by suction, and has no mandibles, could destroy these plants so totally." *

ITS INJURIES IN 1874.

Though we have had previous bad Chinch Bug years, of which the more recent ones of 1864, 1868 and 1871 may be mentioned, yet I doubt whether in any one previous year it has occasioned such widespread destruction. Its greatest injury is usually confined to the spring wheat belt, which includes, roughly speaking, South and Central Illinois, North and Central Missouri, South Nebraska and Kansas;

* Introduction to Entomology, London, 1828, Vol. I, p. 171.

but its ravages the past year were reported over a far wider range of country, and extended south to Texas and Arkansas and east to Virginia. Even in Kentucky, where it does not usually attract much attention, Mr. John C. Noble, of Paducah, wrote me last June that the corn in the western counties was being ruined by it. Any estimates of the loss to the country at large must necessarily be crude, and the figures would foot up till they would appear incredible. I shall therefore confine myself more particularly to

ITS INJURIES IN MISSOURI IN 1874.

From the detailed county returns in the Appendix the estimated loss by counties may be stated as follows:

Adair, $20,000; Andrew, $140,000; Atchison, $217,000; Barry, $80,000; Barton, $100,000; Bates, $500,000; Benton, $350,000; Buchanan, $100,000; Butler, $120,000; Caldwell, $125,000; Cape Girardeau, $40,000; Carroll, $550,000; Cass, $500,000; Cedar, $278,000; Chariton, $600,000; Christian, $45,000; Clark, $50,000; Clay, $350,000; Clinton, $300,000; Cole, $130,000; Cooper, $150,000; Crawford, $90,000; Dallas, $50,000; Daviess, $400,000; DeKalb, $230,000; Douglas, $25,000; Dunklin, no bugs; Franklin, $160,000; Gasconade, $65,000; Gentry, $220,000; Greene, $300,000; Grundy, $125,000; Harrison, $255,000; Henry, $600,000; Hickory, $130,000; Holt, $540,000; Howard, $50,000; Iron, $180,000; Jackson, $450,000; Jasper, $230,000; Johnson, $700,000; Knox, $30,000; Laclede, $45,000; Lafayette, $550,000; Lawrence, $210,000; Lewis, $58,000; Linn, $160,000; Macon, $155,000; Madison, $27,000; Maries, $100,000; Marion, $90,000; Mercer, $250,000; Mississippi, $15,000; Monroe, $280,000; Montgomery, $100,000; New Madrid, $50,000; Newton, $85,000; Nodaway, $100,000; Oregon, $10,000; Osage, $210,000; Ozark, $40,000; Perry, $50,000; Pettis, $300,000; Platte, $100,000; Polk, $300,000; Pulaski, $75,000; Putnam, $100,000; Ralls, $80,000; Randolph, $20,000; Ray, $250,000; Ripley, $40,000; St. Charles, $25,000; St. Clair, $375,000; St. Francois, $100,000; St. Genevieve, $125,000; Saline, $450,000; Scotland, $100,000; Scott, $50,000; Shelby, $50,000; Sullivan, $65,000; Taney, $45,000; Texas, $70,000; Vernon, $225,000; Warren, $120,000; Washington, $100,000; Wright, $60,000.

The aggregate loss from these counties foots up, therefore, to $15,385,000. From the remaining 28 counties, either no reports have been received, or they have been too meagre to form a basis on which to estimate. Some of these counties are not thickly settled, but, estimating by the census returns for 1870, and by the counties which have reported, and which made similar returns, the loss to these 28 counties would amount to about $3,615,000—making the total loss for the State, *nineteen million dollars!*

These calculations do not include any other than the three staple crops of wheat, corn and oats, and are based on the U. S. Census Report of 1870, and on average prices of 90c per bushel for wheat, 50c for corn and 60c for oats.

In taking no account of the increased acreage since 1870, nor of other cereals than those mentioned; and in estimating at prices below present market rates, the damage by drouth, independent of Chinch Bug, is fully offset, and the calculation must be below rather than above the mark. I am aware of the difficulty always encountered in endeavoring to get accurate crop reports and estimates; and, indeed, anything like accurate agricultural statistics is almost impossible in this country; yet the above figures cannot be far out of the way, and will certainly astonish our legislators, and even the farmers of the State, few of whom have any just conception of the vast sum this apparently insignificant little bug filches from their pockets. That the sum here given is below the actual loss will be appreciated all the more when I state that the estimated money loss through the Chinch Bug in Illinois, in 1864, was over seventy-three million dollars. The damage does not even stop here, but brings many serious indirect evils in its train. In a number of counties the farmers have not had sufficient grain to fatten their stock, and have been obliged to sell them at ruinous prices; or, hoping to bring their animals through the winter, and disappointed by its unprecedented and prolonged severity, they have seen their stock die off without power to avoid the calamity. In some counties, and especially south of the Dent county line, the distress has been so great that the Legislature was appealed to for aid in keeping the sufferers from actual starvation, but a bill appropriating $50,000 for this purpose failed to pass both Houses.

ITS FOOD PLANTS.

It may be stated as a rule, which admits of very few exceptions, that the Chinch Bug is confined to, and can subsist only on, the juices of the grasses and cereals; its original food, when the red man ruled the land, being the wild grasses.* All accounts, therefore—and such accounts are coming to me constantly—of chinch bugs injuring grape vines, potatoes, etc., are based on the error of persons who mistake for the genuine article some one or other of the species which will be presently referred to as bogus or false chinch bugs. It is true that Packard, in his "Guide to the Study of Insects," says, in speaking of the Chinch Bug, that "they also attack every description of garden vegetables, attacking principally the buds, terminal shoots, and most succulent growing parts of these and other herbaceous plants;" but this statement is the result of bad compilation, the language, which is quoted from Harris, having reference, in the original, to the Tar-

* I have found the young around the roots of strawberry plants, under circumstances which lead me to believe that they can feed upon this plant.

nished Plant Bug (*Capsus oblineatus* Say), which, as may be seen from my second report, (p. 114), really has such an omnivorous habit. Though, therefore, the subject of our present sketch is restricted to certain families of plants, yet it manifests a decided preference for some of the grains over others. Thus it shows a great predilection for Hungarian grass; while of the more important cereals it is most severe on spring wheat and barley.

MODE OF REPRODUCTION AND HIBERNATION.

"Most insects—irrespective of the Order to which they belong—require 12 months to go through the complete cycle of their changes, from the day that the egg is laid to the day when the perfect insect perishes of old age and decrepitude. A few require 3 years, as for example the Round-headed Apple-tree Borer (*Saperda bivittata* Say) and the White Grub which produces the May-beetle (*Lachnosterna quercina* Knoch.) One species, the Thirteen-year Locust (*Cicada tredecim* Riley), actually requires 13 years to pass from the egg to the winged state; and another, the Seventeen-year Locust (*Cicada septemdecim* Linn), the still longer period of 17 years. On the other hand there are not a few that pass through all their three states in a few months, or even in a few weeks; so that in one and the same year there may be 2, 3 or even 4 or 5 broods, one generated by the other and one succeeding another. For example, the Hessian Fly (*Cecidomyia destructor* Say), the common Slug-worm of the Pear (*Selandria cerasi* Peck), the Slug-worm of the Rose (*Selandria rosæ* Harris), the Apple-worm and a few others, produce exactly two generations in one year, and hence may be termed "two-brooded." Again, the Colorado Potato-beetle in Central Missouri is three-brooded, and not improbably in more southerly regions is four-brooded. Lastly, the common House-fly, the Cheese-fly, the various species of Blow-flies and Meat-flies, and the multifarious species of Plant-lice (*Aphidæ*) produce an indefinite number of successive broods in a single year, sometimes amounting, in the case of the last named genus, as has been proved by actual experiment, to as many as nine.

"As long ago as March, 1866, I published the fact that the Chinch Bug is two-brooded in North Illinois (*Practical Entomologist*, I, p. 48), and I find that it is likewise two-brooded in this State, and most probably in all the Middle States. Yet it is quite agreeable to analogy that in the more Southern States it may be three-brooded. For instance, the large Polyphemus Moth is single-brooded in the Northern and Middle States, and yet two broods are sometimes produced in this State, while in the South it is habitually two-brooded. Again, the moth known as the Poplar Spinner (*Clostera Americana* Harris), is

stated by Dr. Harris and Dr. Fitch to be only single-brooded in Massachusetts and New York, the insect spinning up in September or October, passing the winter in the pupa state, and coming out in the winged form in the following June. But Dr. Harris—no doubt on the authority of Abbott—states that 'in Georgia this insect breeds twice a year;'* and I have proved that it does so breed in Missouri."

"It is these two peculiarities in the habits of the Chinch Bug, namely, first, its continuing to take food from the day of its birth to the day of its death, and, secondly, its being either two-brooded or many-brooded, that renders it so destructive and so difficult to combat. Such as survive the autumn, when the plants on the sap of which they feed are mostly dried up so as to afford them little or no nourishment, pass the winter in the usual torpid state, and always in the perfect or winged form, under dead leaves, under sticks of wood, under flat stones, in moss, in bunches of old dead grass or weeds or straw, and often in cornstalks and cornshucks.

"In the winter, all kinds of insect-devouring animals, such as birds, shrew mice, etc., are hard put to it for food, and have to search every hole and corner for their appropriate prey. But no matter how closely they may thin out the chinch bugs, or how generally those insects may have been starved out by the autumnal droughts, there will always be a few left for seed next year. Suppose that there are only 2,000 chinch bugs remaining in the spring in a certain field, and that each female of the 2,000, as vegetation starts, raises a family of only 200, which is a low calculation. Then—allowing the sexes to be equal in number, whereas in reality the females are always far more numerous than the males—the first or spring brood will consist of 200,000, of which number 100,000 will be females. Here, if the species were single-brooded, the process would stop for the current year; and 200,000 chinch bugs in one field would be thought nothing of by the Western farmer. But the species is not single-brooded, and the process does NOT stop here. Each successive brood increases in numbers in geometrical progression, unless there be something to check their increase, until the second brood amounts to twenty millions, and the third brood to two thousand millions. We may form some idea of the meaning of two thousand millions of chinch bugs when it is stated that that number of them, placed in a straight line head and tail together, would just about reach from the surface of the earth to its central point—a distance of four thousand miles."

WHERE THE EGGS ARE LAID.

The Chinch Bug deposits its eggs occasionally above ground on

* *Injurious Insects*, p. 434.

the blades of grain, but far more often, and normally, underground, upon the roots of the plants infested. These eggs are three-hundredths of an inch long, elongate oval, pale amber-colored and with one end squarely docked off and ornamented with four little tubercles near the centre. (Fig. 3, *a.*) They are deposited in little clusters, and the young lice hatching from them are at first bright red and remain for a considerable time underground, sucking the sap from the roots. A wheat plant pulled from an infested field in the spring of the year, will generally reveal hundreds of these eggs attached to the roots, and at a somewhat later period, the young larvæ will be found clustering on the same, and looking like so many moving red atoms. As the sequence will show, it is practically quite important that we know the whereabouts these eggs are deposited; yet they are so small and so difficult of detection that the wildest theories were promulgated as to the origin and birth of chinch bugs, until the question was settled by the entomologist with his lens and microscope. The female occupies from two to three weeks in depositing her eggs; the egg requires about two weeks to hatch, and the bug becomes full-grown and acquires its wings in five or six weeks from hatching.

Individuals may be found of all sizes and ages throughout the summer months, yet the great body of the first brood mature soon after the ripening of spring wheat.

Insects generally lay all their eggs in single masses and in a comparatively brief time: in other words, the eggs in the ovaries are almost simultaneously developed, and the female devotes the last of her life to the single and comparatively brief act of oviposition, and then perishes from exhaustion. In the Chinch Bug, however, as in the Colorado Potato-beetle, Plum Curculio, etc., the ova continue to develop for several weeks, and the eggs are laid from day to day in small numbers.

FLIGHT OF THE CHINCH BUG.

Though, as we have already seen, there is a dimorphous, short-winged form, incapable of flight, and found more particularly in northern latitudes, the normal, long-winged form is abundantly able to fly, and is sometimes seen swarming in the air. This flight is most noticeable at three periods in the year. First, during the early warm days of Spring, when—issuing from their winter quarters—the individuals of the second or hibernating brood perform their courtships, and the females scatter over the wheatfields and seek the driest and most open soil, that they may penetrate to the roots of the plants and there consign their eggs. Secondly, in July, after wheat is harvested, and the great body of the first brood have acquired wings and are per-

forming their courtships and scattering over cornfields and meadows. Thirdly, during the latter sunny days of Fall, when the mature individuals of the second brood are seeking their winter quarters, and many of them already making love preparatory thereto.

ITS MIGRATION ON FOOT.

Although the Chinch Bug is abundantly able to fly, yet as a rule it does not take to wing readily. Indeed, between the periods of flight mentioned above, these insects are, for the most part, unable to fly, for the simple reason that they are in the adolescent growing stages, and have not yet acquired wings; for no insect acquires wings until it has attained the imago or full grown state. Thus in migrating from a field of grain after it has been reduced and exhausted, or in passing from a wheatfield to a cornfield, after the wheat has been cut, these myriad sappers and miners are forced to march on foot, and they often do so in solid columns, inches deep. In such case the few more early matured individuals, which have wings, generally keep with the crowd and show no inclination to use their recently acquired power of flight.

HEAVY RAINS DESTRUCTIVE TO THE CHINCH BUG.

"As the Chinch Bug, unlike most other true bugs, deposits its eggs underground, and as the young larvæ live there for a considerable time, it must be manifest that heavy soaking rains will have a tendency to drown them out. The simple fact, long ago observed and recorded by practical men, such as Mr. B. E. Fleharty, of North Prairie, Knox county, Ill., that this insect scrupulously avoids wet land, proves that moisture is naturally injurious to its constitution. Hence it was many years ago remarked that very often when spring opens dry, chinch bugs will begin to increase and multiply in an alarming manner; but that the very first heavy shower checks them up immediately, and repeated heavy rains put an almost entire stop to their operations. It is very true that nearly all insects will bear immersion under water for many hours, and frequently for a whole day, without suffering death therefrom; for although animation is apparently suspended in such cases, they yet, as the phrase is, 'come to life again.' But no insect, except the few that are provided with gills like fishes and extract the air out of the water, instead of breathing it at first hand, can stand a prolonged immersion in water without drowning—and it must be obvious to the meanest capacity that an insect such as the Chinch Bug, whose natural home is the driest soil it can find, will have its health injuriously affected by a prolonged residence in a wet soil.

"In fact, the whole history of the Chinch Bug, from the very earliest records which we have of it, points unmistakably to the fact that a wet season affects it injuriously, and often almost annihilates it. In Carolina and Virginia, during the dry years which preceded 1840, it had become so numerous that the total destruction of the crops was threatened; but fortunately, unlike its predecessors, the Summer of 1840 was quite wet, and the ravages of the bug were at once arrested. In Illinois and in this State it had increased to an alarming extent during the latter part of the last rebellion; but the excessive wet Summer of 1865 swept them to such an extent that it was difficult to find any in the Fall of that year. So it was again in 1869–70, and so it always has been and doubtless will be."

It will be remembered that in some parts of the State we had several generous rains in July which were most grateful after the preceeding excessively dry weather. No one who was not in and about the cornfields can have any idea of the almost magic effect of those rains in destroying the chinch bugs. Of the vast swarms that a few weeks before, had blackened and deadened the rows of corn adjacent to harvested wheatfields, fully two-thirds in many localities were dead and rotting, whether above the ground between the blades, or below ground upon the roots; and these dead and drowned comprised bugs of all ages, and especially the larvæ and pupæ.

DIRECT REMEDIES AGAINST THE CHINCH BUG.

When a field of wheat or barley or rye, is once overrun by chinch bugs, man is, in the majority of cases, powerless before the unsavory host, and his only hope is in timely rains. The great majority of noxious insects may be controlled even at the last hour, but a few—and among them is the Chinch Bug—defy our efforts when once they are in full force upon us. There are several applications that will kill the insect when brought in contact with it, and I have known a few rows of corn to be saved by the copious use of simple hot water, but the application of all such direct remedies becomes impracticable on the scale in which they are needed in the grain fields of the West. Irrigation, where it can be be applied—and it can be in much of the territory in the vicinity of the Rocky Mountains, where the insect commits sad havoc; and with a little effort, in many regions in the heart of the Mississippi Valley—is the only really available, practicable remedy, after the bugs have commenced multiplying in the spring. *I wish to lay particular stress on this matter of irrigation*, believing as I do, that it is an effectual antidote against this pest, and that by overflowing a grain field for a couple of days, or by saturating the ground for as many more in the month of May, we may effectually pre-

vent its subsequent injuries. In the article on the Rocky Mountain Locust, I may have something more to say on this matter of irrigation. We cannot, at the critical moment, expect much aid from its natural enemies, for these are few, and attack it mostly in the winter time. We must, therefore, in our warfare with this pest, depend mainly on preventive measures where irrigation is impossible.

PREVENTIVE MEASURES.

It has been repeatedly shown in these pages, that in no department of science does the old proverb, "prevention is better than cure," apply with such force as in economic entomology; for there are hosts of insects whose depredations may be averted with the utmost ease, when we understand their weak points and attack them at the proper place or time. Though we are powerless before the Chinch Bug at the time it commits the greatest injury, and attracts most attention, yet I shall endeavor to show that it may, for all practical purposes, be outflanked by judicious husbandry and proper precautionary steps.

Burning—It has long been noticed that the Chinch Bug commences its ravages in the Spring from the edges of a piece of grain, or occasionally from one or more small patches, scattered at random in the more central portions of it, and usually dryer than the rest of the field. From these particular parts it subsequently spreads by degrees over the whole field, multiplying as it goes, and finally taking the entire crop unless checked up by seasonable rains. In newly broken land, where the fences are new, and consequently no old stuff has had time to accumulate along them, the Chinch Bug is seldom heard of. These facts indicate that the mother insects must very generally pass the winter in the old dead stuff that usually gathers along fences. Hence, by way of precaution, it is advisable, whenever possible, to burn up such stuff in the winter, or early in the spring, and particularly to rake together and burn up the old corn stalks in the fall of the year, instead of plowing them in, or allowing them, as is often done, to lie littering about on some piece of waste ground. Agriculturally speaking, this may not be the best way of enriching the soil; but it is better to lose the manure contained in the corn stalks than to have one's crop destroyed by insects. Whenever such small infected patches in a grain field are noticed early in the season, the rest of the field may often be saved by carting dry straw on to them, and burning the straw on the spot, Chinch Bugs, green wheat and all; and this will be still easier to do when the bugs start along the edge of the field. If, as frequently happens, a piece of small grain is found about harvest time to be so badly shrunken up by the

bug as not to be worth cutting, the owner of it ought always to set fire to it and burn it up along with its ill-savored inhabitants. Thus, not only will the insect be prevented from migrating on to the adjacent corn-fields, but its future multiplication will be considerably checked.

As was clearly shown by Dr. LeBaron, in his second report as State Entomologist of Illinois, much of the efficacy of burning corn stalks will depend on the manner in which it is performed and the time of year of its performance. The approach of Winter finds the bugs scattered everywhere over our corn-fields. But the fields themselves afford very little Winter shelter, and though standing corn stalks may harbor the bugs more or less throughout the Winter, the fact remains that the majority of the bugs leave them and seek greater shelter and more favorable quarters. Thus, to be effectual, the stalks should be cut and burned before Winter sets in; or what is preferable, shocks should be made at intervals to attract the bugs. The bugs will then congregate in these shocks and may there be burned at any time during the winter. In this connection I will quote the following inquiry from Mr. J. T. Moulton, Jr., of St. Francois county:

> The most compact and destructive army of chinch bugs I ever saw, started from sorghum bagasse, which had been used as manure. Might the insects be trapped to any extent worth mentioning, by exposing heaps of rubbish in conspicuous places in August, and burning the same in November? Would a great proportion of the eggs be found in such heaps?

The eggs would of course not be found in such heaps, as they are laid only on the living grain, and principally below the surface of the ground at the crown or on the roots of the plant. But they would nevertheless be effectually destroyed in the manner you suggest, because each female bug sheltering under the bagasse carries within her ovaries a number of undeveloped eggs which, as soon as Spring opens, she is ready to consign to the roots of young grain. The plan suggested by Mr. Moulton is therefore a capital one; and it matters little whether bagasse, corn-stalks, or any other rubbish be used, so long as the heaps are not too large and compact, and are placed and destroyed by fire at the times mentioned.

Where the custom of allowing cattle to range during the winter in the husked corn-fields, even the few chinch bugs which secrete in these stalks are apt to get killed by the feeding and tramping.

ROLLING—As the mother Chinch Bug has to work her way under ground in the spring of the year, in order to get at the roots upon which she proposes to lay her eggs, it becomes evident at once that the looser the soil is at this time of the year the greater the facilities

which are offered for the operation. Hence the great advantage of plowing land for Spring grain in the preceding Autumn, or, if plowed in the Spring, rolling it repeatedly with a heavy roller after seeding. And hence the remark frequently made by farmers, that wheat harrowed in upon old corn ground, without any plowing at all, is far less infested by Chinch Bug than wheat put in upon land that has been plowed.

INVIGORATING THE PLANT BY MANURE: EARLY SOWING, ETC.—It has long been observed that Fall wheat suffers less than Spring wheat from this insect, for the simple reason that it generally matures before the bugs have attained their greatest power for harm. The Tappahannock wheat, on account of its early ripening, is, for this reason, one of the safest kinds to grow. There is also a strong impression among those who have had a good deal of experience with the insect, that it thrives best on sickly and weakly grain. While in such questions it is always somewhat difficult to distinguish between cause and effect, the following experience of that close observer, Mr. J. R. Muhleman, of Woodburn, Illinois, would certainly seem to show that the bugs do show some choice of food in a corn-field:

> I had a piece of very vigorous corn opposite my neighbor's wheat, and after it was harvested, that corn nearest the wheat became black with bugs. Now, the small field on which I raised my corn, is various in quality, ranging from rich to barren. My supply of manure did not hold out to cover all the latter, so that the corn thereon grew but slowly and remained weak. About a week after I had first noticed the bugs on that strong fast-growing corn, as mentioned above, I passed again by it, and found the bugs had abandoned it. That corn, and that which grew on the manured portions of the field remained free from the bugs during the remainder of the season, and I began to think the bugs had left entirely; that corn turned out well—as well as it promised in the forepart of the season.
>
> At the time of cutting the corn I became undeceived, for I found all the *weak* corn full of the stinkers, suggesting to me that they had thus abandoned the big heavy stalks, because, as I suppose, the sap flowed too fast for their comfort, and they went at the more etiolated, slowly growing corn. Upon frequent inquiry in different parts of the county, I have found that corn growing in bottoms was comparatively free from the bugs and made good corn, while upland corn, and especially such grown on rather thin land, was destroyed by them.
>
> The lesson I would therefore draw from these observations is, that early planting, manuring, and close attention in cultivation, especially on uplands of poor soil, will reward the tiller with a reasonable yield, as far as the Chinch Bug is concerned.

There can be no doubt as to the soundness of the lesson my friend draws in the last paragraph, and much of the freedom from chinches that has been noticed to follow the steeping of the seed in brine, or the use of salt and lime on the soil, may be traced to the vigor which the applications gave to the plants.

MIXING SEED OR PROTECTING ONE PLANT BY ANOTHER.—A strip of Spring wheat might be sown around a field of Fall wheat, as suggested by Mr. Carr (see Appendix), so that when the bugs have sucked it dry, or as soon as the Fall wheat is cut, and before they have started for

other fields, the Spring wheat with its contents may be burned. Other preventive measures of this character have been tried, such as the sowing of a rod or two of Hungarian grass or millet around a wheat field, with a view of satisfying the bugs till the desired crop is out of danger. I have also known some to practice planting a few rows of sorghum, which is tougher than the corn. The bugs remain on the sorghum till ready to scatter by wing, when there is little danger to the corn, because it is then too strong and vigorous to be much affected by the young of the second brood.

PREVENTING THE MIGRATION OF THE BUGS FROM ONE FIELD TO ANOTHER.—When, after having exhausted a field of grain, they are marching to another; or when, after wheat is cut, they are making in close columns for the nearest corn, they may be checked in their progress in the following manner, which I give in the words of Mr. H. J. Everett, of Stoughton, Wisconsin, who first recommended it:

Take common fence boards, six inches or less wide, and run them around the piece, set edgewise, and so that the bugs cannot get under them or between the joints, and then spread either pine or coal tar on the upper edge, and they will not cross it. The tar needs renewing until the edge gets saturated, so that it will keep wet and not dry in any more, and either kind of tar is effectual. Then dig holes close to the board, about like a post hole, once in four or five rods, and run a strip of tar from the top of the board to the bottom on the outside, opposite the hole, and they will leave the board, and in trying to get around the tarred stripe, will slide into the hole, where they will be obliged to remain till they can be buried at leisure, and new holes opened for more victims. It is seldom one has to fence more than one side of the field, but wherever the fence is it is a sure stop.

With a little care to keep the tar moist by renewal, the boards may be dispensed with, and the tar poured out of the kettle onto the ground. About a gallon is required to a rod, and it should be renewed every other day, or oftener when rains prevail, until the bugs are destroyed in the manner before indicated. According to Dr. LeBaron, this plan was extensively resorted to in 1871, around Bloomington, Illinois, where the coal tar could be easily obtained, and it gave most satisfactory results. The same end may be attained by plowing a deep furrow or two at a short distance one from the other around a field it is intended to protect; and from the ease and cheapness with which this plan is executed, it is likely to become the most popular. The earth should be thrown away from the protected field, and the furrow not allowed to settle or harden, but be kept friable or dusty by dragging a log or a stone or a bundle of brush along it each morning. The philosophy of the plan is that the bugs cannot climb up the loose surface, especially on the perpendicular side. The dragging each morning will kill many, but they should be either

trapped and destroyed in pits as already described, or burned by strewing straw each morning on the invading side of the furrow, and burning the same each evening, when a chinch bug holocaust will result.

IMPORTANCE OF WINTER WORK AND COMBINED ACTION.

Measures such as these last are, however, but partially preventive; we destroy the enemy only after he has just committed his principal ravages. Those, therefore, which strike at the right place and prevent the bug from doing any injury, are by far the most important and valuable; and I cannot lay too much stress on the importance of Winter work in burning cornstalks, old boards and all kinds of grass, weeds, rubbish and litter around grain fields, and even the leaves in the adjacent woods, in and under all of which the little pest hibernates. Next to drowning out the rascals, cremation is undoubtedly the most effectual mode of destruction. Next, let Spring wheat be got in as early as possible, and let it be rolled. The rolling will apply equally well to the culture of Winter wheat, though I would not advise the early Fall planting of this last in sections where it is likely to suffer from Hessian fly, for reasons not pertinent in this connection. Sow thickly, as the more the ground is shaded the less the Chinch Bug likes it. If in late Winter the bugs are known to be numerous so as to bode future injury—and the fact can easily be ascertained by the ill-savored odor they send up from corn-shocks and by their general presence in the wintering places mentioned—it will be well to plant no Spring wheat or barley. In short, just in proportion as we adopt an intelligent and cleanly system of culture, just in that proportion will the Chinch Bug become harmless: it is, in a great part, and in its more injurious aspects, a result of slovenly husbandry, and will lose its threatening character in the more western States, as it has in those to the east of us, just as fast as more careful and intelligent husbandry becomes the fashion. Combined effort is, also, most important in this connection, and it is by producing unity of action in such cases that the granges can demonstrate, in no small degree, the good that is to flow from organization. While the farmers were uncombined they were as weak as a rope of sand in matters requiring this combined effort, but with the powerful organization now existing among them, they will be better able to cope with their foes of whatever nature.

Every one who has traveled over our own State, must have been struck with the manner in which some fields were rendered almost worthless by this insect; while others in the immediate vicinity, and

sometimes not more than a quarter of a mile away, were entirely exempt from its injuries. I have had no difficulty in accounting for these circumstances in the light of what is here stated.

Much good winter work may be done also in the way of trapping the bugs. In seeking winter quarters, they show a decided partiality for any flat substances, such as old boards, that do not rest too closely upon the ground. If all old boards that can be obtained are laid around a field, in the Fall, in such manner that the larger part of the lower surface will not quite rest on the ground—which of course it will not do if the ground is in the least bit uneven or covered with grass—the bugs will congregate under such traps, and during the cold weather of Winter may be scraped from them on to dry straw and burned.

In this connection, and to show the folly of waiting till the last moment, I take the liberty of publishing the following letter as a sample of many that reach me about harvest time:

DEAR SIR: I once noticed in the Kansas agricultural reports an article from your pen on noxious insects, and how to destroy them, and a few days since I read in the St. Louis *Globe* of the good work you were doing. I now write to you in the hope that you can do as good a turn for a sad lot of farmers as you did for Mr. Whittaker.

We are being eaten out by the Chinch Bug; Spring wheat and barley utterly ruined—none left to eat; Winter wheat damaged one-half, and whole fields of corn being laid waste. I hear of many instances where from ten to fifteen acres are gone, and the bugs marching steadily on. A few persons are trying to stop them by spreading straw in their way and burning or dragging logs; some are trying coal tar; but generally the bugs are marching onward.

I look from my window on a fine, large field of oats over half ruined. Many are cutting oats in the bloom or milk to save something.

I have seen grasshoppers twice, and would prefer them of the two. If you can tell us something about them and how to prevent their ravages, drive off or destroy them, you will confer upon us the greatest favor and receive our heartfelt thanks.

Wishing you God-speed in your noble efforts to help our insect-cursed country,

I am, with respect,

H. V. NEEDHAM,

Master of Grange No. 71, P. of H.

SUMMIT, Kansas.

All such letters, when they come from citizens of Missouri, I make it a point to answer, as far as other duties will permit; but from the rather lengthy account of the Chinch Bug here given, it is obvious that relief in all cases like that of Mr. Needham, is sought at the last moment, when it cannot be got except through providential rains or irrigation. Yet it is always at this last moment that the cry of distress goes up from the large body of farmers, or that any efforts are made to avert it, except by the few who have been properly informed and understand the habits of the enemy. That these last form but a small (though I am happy to say constantly increasing) portion of the agricultural community is, perhaps, to be regretted. A practicable,

everywhere available, cheap remedy, that would give relief at this critical period, is from the nature of the case, hardly to be hoped for. Yet it is not an impossibility; and if I could devote to the effort my whole time for one single year, with the means to test on a large scale, thoroughly and effectually, the many different methods that suggest themselves to my mind—as the use of sulphate of copper or of iron; of carbonic acid gas or of sulphuret of carbon—something might come out of the list of possible remedies, and thousands of dollars might be cheaply expended in the attempt where such large interests are involved. Regarding the use of carbonic acid gas, it is probable that it would destroy the bugs on a hill of corn, if thrown on to them at a distance of not more than two feet; but from experiments which I made upon chinches with a Babcock extinguisher, I am of the opinion that little can be expected from its use as thrown from this machine. The gas escapes too rapidly to be of any great practical service, and has no effect on the bugs when thrown in a jet five feet long.

ABSTAINING FROM THE CULTIVATION OF THE GRAINS UPON WHICH THE INSECT FEEDS.—On the principle that it is better to save the labor and seed than to lose both and the harvest withal, the idea of quitting the culture of the cereals, and especially of Spring wheat and barley, for a year or two, as a means of preventing the breeding of the insect to any injurious extent, has often been considered and discussed. There is some reason to believe that the abandonment, for a single year, of barley and Spring wheat culture, over a sufficiently large extent of country—as, for instance, over a whole county—would cause a sufficient reduction in the numbers of chinch bugs in such a county, as to insure fair crops for two or three succeeding years; and such a course is well worth trying. It is to be feared, however, that it will never be carried out in concert over a sufficiently extended breadth of country; 1st, because the farmer can never foretell the character of the coming season, on which the increase or decrease of the pest so largely depends, and will naturally hope for the best; 2d, because if neither Spring nor Fall wheat, barley, oats, rye, Hungarian grass, timothy nor corn were grown for one season in any given county where there are wild prairie grasses, the Chinch Bug would yet breed, though not so numerously.

NATURAL ENEMIES.

Practically we have not much to hope for from the natural enemies of this bug; for they are neither numerous nor efficient enough to

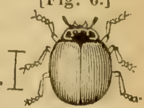
make any material impression on the vast army of chinches which invade our grain fields; neither are they of such a nature as to be greatly encouraged, or artificially multiplied for man's good, as in wholesale measures of destruction it is impossible to separate the sheep from the goats. Yet it will afford some satisfaction to the farmer to be able to recognize even these few friends which assist, in their quiet way, to keep his inveterate foe in check.

"As long ago as 1861, Mr. Walsh, in his *Essay upon the Injurious Insects of Illinois*, published facts which tended to show that four distinct species of Ladybirds preyed upon the Chinch Bug.* The first of these four is the Spotted Ladybird (*Hippodamia maculata*, DeGeer, Fig. 5), which also preys upon a great variety of other insects, attacking both the eggs of the Colorado Potato-beetle and those of certain Bark lice.

[Fig. 5.]

Spotted Ladybird.

[Fig. 6.]



Trim Ladybird.

"In corroboration of the fact of its preying on the Chinch Bug, I may state, that the Rev. Chas. Peabody, of Sulphur Springs, informs me that he has repeatedly found it so feeding on his farm. The second species is the Trim Ladybird (*Coccinella munda* Say, Fig. 6), which is distinguishable at once from a great variety of its brethren by having no black spots upon its red wing-cases. The other two are much smaller insects, belonging to a genus (*Scymnus*) of Ladybirds, most of the species of which are quite small and of obscure brown colors, and hard to be distinguished by the popular eye from other beetles, the structure of which is very different, and which therefore belong to very different groups and have very different habits.

"In the Autumn of 1864, Dr. Shimer ascertained that the Spotted Ladybird which has been sketched above, preys extensively upon the Chinch Bug. In a particular field of corn, which had been sown thick for fodder, and which was swarming with chinch bugs, he found, as he says, that this Ladybird, 'could be counted by hundreds upon every square yard of ground after shaking the corn; but the chinch bugs were so numerous that these hosts of enemies made very little perceptible impression among them.'

"In the same Autumn Dr. Shimer made the additional discovery, that in the very same field of fodder-corn the chinch bugs were preyed upon by a very common species of Lacewing-fly, which he described in January, 1865,† as the Illinois Lacewing (*Chrysopa Illi-*

* See *Trans. Ill. St. Agric. Society*, IV, pp. 346-9.

† Proc. Ent. Soc. Phil., IV, pp. 208-12.

noiensis). The description was republished, together with the substance of Mr. Shimer's observations in the *Prairie Farmer*, of Chicago, Ill., accompanied with a non-characteristic wood-cut of the larva, cocoon and imago. At this time Mr. Shimer favored me with two specimens of the perfect insect, and he likewise furnished Mr. Walsh with additional specimens. From these specimens, it is evident that the species is the same as that described long before, by Dr. Fitch, as the Weeping Lacewing (*Chrysopa plorabunda*). In 1868, I found the same species quite numerous in a wheat-field belonging to Mr. T. R. Allen, of Allenton, where its larvæ were perhaps feeding on the chinch bugs, as they were found to do in North Illinois, by Dr. Shimer. The Lacewing-flies all bear a striking resemblance to one another, both in size, shape and color. They almost all of them, in fly state, have a characteristic and disagreeable odor, resembling nothing so much as human ordure. (For further details see Rep. 1, pp. 57–8, and Rep. 6, Fig. 10).

"According to Dr. Shimer, the Weeping Lacewing-fly was not quite as abundant as the Spotted Ladybird among the fodder-corn, but still there were so many of them, that he thought that 'there was one or more of them for every stalk of that thickly sown corn.' 'Every stroke of the cutter,' he adds, 'would raise three or four dozen of them, presenting quite an interesting spectacle as they staggered along in their awkward, unsteady flight.' And he not only actually observed the larvæ preying very voraciously on the chinch bugs in the field, but he reared great numbers of them to the mature fly by feeding them upon chinch bugs. His account of the operations of the larva when in captivity is so interesting that I quote it in full:

I placed one of the larvæ in a vial, after having captured it in the field in the very act of devouring chinch bugs of all sizes, and subsequently introduced into the vial a number of chinch bugs. They had hardly reached the bottom before it seized one of the largest ones, pierced it with its long jaws, held it almost motionless for about a minute while it was sucking the juices from the body of its victim, and then threw down the lifeless shell. In this way, I saw it destroy in quick succession, about a dozen bugs. Towards the last, as its appetite was becoming satiated, it spent five or more minutes in sucking the juices from the body of one bug. After this bountiful repast, it remained motionless for an hour or more, as if asleep. Never for a single moment, during the feast, did it pause in the work. When not in possession of a bug, it was on the search for, or in the pursuit of others. It manifested much eagerness in the pursuit of its prey, yet not with a lion-like boldness; for on several occasions I observed a manifest timorousness, a halting in the attack, as if conscious of danger in its hunting expeditions, although here there was none. Sometimes, when two or more bugs were approaching rapidly, it would shrink back from the attack, and turning aside go in the pursuit of others. At length, awakening, it would renew the assault as before. On one occasion, when it was on the side of the vial, two inches up, with a large bug in its mouth, I jarred the vial, so that it fell to the bottom and rolled over and over across the bottom, but holding on to its prey, it regained its footing and mounted up to its former position. Occasionally the chinch bugs would hasten to escape when pursued, as if in some degree conscious of danger.

[Fig. 7.]

INSIDIOUS FLOWER-BUG.

The Insidious Flower-bug (*Anthocoris insidiosus*, Say, Fig. 7.) which is so often found preying on the leaf-inhabiting form of the Grape Phylloxera, and which is not unfrequently mistaken for the Chinch Bug, is quite commonly found in connection with this last, and in all probabitity preys upon it.

[Fig. 8.]

MANY-BANDED ROBBER.

The Many-banded Robber (*Harpactor cinctus*, Fabr. Fig. 8.), also preys upon the Chinch Bug. It is quite frequently met with and I have detected it in the act.

"The common Quail of the Middle and Western States (*Ortyx Virginiana*) otherwise known as the Partridge in the Northern States, has long since been known as a most efficient destroyer of chinch bugs, and the fact was some time ago published by myself in the *Prairie Farmer*, and by others in various agricultural journals and Reports. We also have the corroborative testimony of Dr. Shimer, who is a good ornithologist. In the Winter time, when hard pushed for food, this bird must devour immense numbers of the little pests which winter in just such situations as are frequented by the Quail; and this bird should be protected from the gun of the sportsman in every State where the Chinch Bug is known to run riot." It is gratifying to know that this fact has become sufficiently recognized to have gained for the bird legislative protection in Kansas. Prairie chickens are also reported as devouring it, but I do not know that any absolute proof has been given. Mr. J. W. Clarke, of Green Lake county, Wis., also reports seeing the Red-winged Blackbird feeding on it.* Finally, Mr. B. W. Webster, of Austin, Cass county, and G. C. Brackett, Secretary of the Kansas State Horticultural Society, have both written me to the effect that ants destroy its eggs.

POSSIBLE REMEDIAL AND PREVENTIVE MEASURES THAT NEED FURTHER AND THOROUGH TRIAL.

There are a number of *possible* remedies or preventive measures that suggest themselves to any one having a thorough acquaintance with the insects' economy, the thorough trial and test of which will require much time, labor and expense. There are others which are from year to year continually recommended on pretty good authority.

Prairie Farmer, April 9, 1870.

None of them can be recommended with any assurance; yet it will be well to enumerate a few of the more plausible, as worthy of more thorough trial, in the hope that some of our Western Agricultural Colleges, having the opportunities and facilities, will be induced to carry out such a system of carefully conducted experiments, as will forever settle the question of their utility—a system which it is impossible for the State Entomologist of Missouri to carry out, with present means and duties.

In June, 1871, Mr. Wm. F. Talbott, of Richmond, Ills., strongly recommended in the columns of the *Missouri Republican* the use of salt and brine—the salt to be sown with the seed at the rate of about a half barrel to the acre and the brine to be poured on the plants. The recommendation was extensively copied, but subsequent trial has proved that the bugs are not particularly affected by it. Yet as a fertilizer and by invigorating the plant and hastening its maturity so that it will ripen before the insect acquires the greatest power for harm, such an application may prove highly beneficial; and this fact will account no doubt for some of the favorable reports of the use of salt. The same may be said of lime and gas lime which have been extolled by some and denounced by others as chinch bug antidotes.

There is a very general impression that hemp is obnoxious to the Chinch Bug, and no end of instances are reported where grain crops surrounded or interspersed with it have been unmolested, while other adjacent fields have been injured. The testimony is, however, somewhat conflicting. Flax, too, is recommended as having the same power of protecting from chinch bug ravages; and Mr. S. T. Kelsey, of Hutchinson, Kans., who is abundantly able to judge intelligently, and has had good opportunity so to judge, reports that last year, in Kansas, small grain planted on ground where flax was grown the previous year, generally escaped damage from the bugs. He recommends sowing with wheat and other grains, one or two quarts of flax seed per acre. "It can be put in early in the spring, even with fall wheat by a light harrowing and rolling, (if a roller can be had) so as to not damage the grain. Its growth could not materially injure the crop, and if the seed ripened it could be easily separated. Some people sow flax and barley mixed on the same ground, separate the seed in cleaning, and claim that it pays better than sowing either one alone. If flax is really offensive to the Chinch Bug, so that they will not stay around it, why may we not "flax" the pests out of our grain fields entirely?"*

* *Kansas Farmer*, January 13, 1875.

Mr. Alfred Gray, the enterprising Secretary of the Kansas State Board of Agriculture, who has made a number of official inquiries, gets substantially the same favorable reports as to the influence of flax.

A similar influence is claimed for castor beans and even for buckwheat; and some years back Mr. Erwin, Agricultural editor of the Fulton (Mo.,) *Mail*, informed me that, having once gotten a poor stand of corn, he harrowed it and sowed to buckwheat. The Chinch Bug almost destroyed the rest of his corn, but did not work on this piece. The tendency of buckwheat to keep the ground moist may throw some light on this experince.

It has been recommended to sow with each 12 bushels of winter wheat, one bushel of Winter rye; and with Spring wheat the same proportion of Winter wheat—with the idea, I suppose, that the bug prefers the young to the old plants. There is little harm in the methods and they are worthy of further trial.

There are a great many other proposed remedies that appear in the columns of our agricultural journals each year—some of them utterly absurd and founded on ignorance; others of doubtful utility, because founded on isolated experience, where too often it is evident that cause and effect have not been properly understood. It is needless to instance them. As to the ridiculous proposal put forth in the Waukegan, Ills., *Gazette* in 1865, with a great blowing of trumpets, by one D. H. Sherman, of that town, namely, to destroy the Chinch Bug in the egg state by pickling all the seed wheat, it is sufficient to observe that this insect never deposits its eggs upon the kernel of the ripe wheat. Consequently, to attempt to kill chinch bug eggs by doctoring the seed wheat, would be pretty much like trying to kill the nits in a boy's head by applying a piece of sticking plaster to his great toe. In the old *Practical Entomologist*, nine years ago, I showed that there were no such eggs in the wheat kernels, which Mr Sherman himself had sent me, and which he had supposed to be thus infested. Of course the same remark applies to every other proposition to destroy this insects' eggs by manipulating the seed—however beneficial such measures may be as a means of invigorating the plants, causing an early start, or preventing rust and smut.

INJURIOUS TO STOCK.

Accounts reached me from several sources, and were common in the agricultural papers, of stock being injured when fed with corn fodder badly infested with the bug; and I have no reason to doubt that animals confined to corn-fodder in seasons when every corn-stalk

harbors dozens or even hundreds of bugs, will suffer from eating them —the symptoms described being a falling off in flesh and constipation. *Verbum sat sapienti.*

PROGNOSTICATING.

After such a Chinch Bug season as we had in 1874, the question is continually asked during the Winter: "Will there be any chinch bugs next Summer?" It is impossible to give any satisfactory answer to such a question, because so much depends on the character of the approaching Spring. We had some very severe and continued cold weather this Winter, and many entertain the hope that the chinches have been frozen out. The farmer must lay no such unction to the soul, however; for it is not intense cold but changeable Winter weather—successive thawings and freezings—that injures and destroys the Chinch Bug.*

UNNECESSARY FEARS.

While some thus take a bright view often unwarranted by the actual facts, others again are unnecessarily pissimistic and hopeless of the future prospects—borrowing trouble where there is, perhaps, no cause for it. This fact may be illustrated by the following letter from Mr. Wm. H. Avery, of Lamar, Barton county, as a sample:

> About a month or six weeks ago, numerous farmers of this county reported finding large quantities of dead chinch bugs on the ground beneath shocks of corn. They were so numerous that double handfuls could be taken up without much effort, and many believed that all the bugs in the country were dead. One man said that he had observed that what appeared to be dead bugs were only the shells or outer covering of bugs, and he believed the bug itself had only escaped from its old covering.
>
> I have not heard of any living chinch bugs being seen for two or three months, though I have not made particular search.
>
> P. S. Since writing the foregoing, Dr. Dunn and I have made search in the fields for living chinch bugs and could find none, while dead ones are abundant.
>
> I send you, in another wrapper, a piece of corn-stalk containing the bugs just as we found them.

Now in the corn-stalk sent, though, on a superficial view, it appeared black with chinches, there was not a single living bug to be found. What had been mistaken for them was a mass of the empty pupa-skins. We have seen, in speaking of the insect's transformations, how, at each successive molt, the colors of the perfect bug are more and more approached, until in the pupa state, both in color and size, there is great resemblance to the mature bug. When about to undergo the last molt, i. e., to shed the pupa-skin, the insects in late

* Since this was written, I have found the Chinch Bug by millions in its Winter quarters, and on the 28th and 29th of March—the weather being quite warm—they already began to move and fly about. This shows that the long and severe Winter had little effect on them.

Summer and Fall, are fond of congregating on corn-stalks in the shelter afforded by the broad blades; and since all insects, in molting, fasten themselves as securely as possible, and as none of them that live by suction, like the Chinch Bug, ever devour their cast-off garments, as many of the mandibulate species are known to do, the cast-off pupa-skins in such corn-stalks remain indefinitely between the blades. Again, many chinch bugs naturally die in the Fall or in the Winter, either from disease or from having run their course; while in some years, as Dr. Shimer has conclusively shown, and as I can testify from personal examination, a very general fatality attends the hibernating bugs, so that it is difficult to find a living one. In all such cases, a little careful research by aid of an ordinary lens will soon enable the farmer to determine whether he is dealing with dead or living chinches, or only their skeletons. The pupa-skins, though distended, with every leg-covering perfect, readily reveal their mocking emptiness under the lens or by the pressure of the finger, and while, when numerous, they speak in unmistaken terms of the large numbers of chinches that came to maturity in the Fall, they bear no evidence of the present strength, nor furnish any clue to the future power of the foe: the dead bugs are generally covered with mold and are discolored and soft: the living ones are bright-colored, and will soon begin to kick and crawl on being brought into a warm room.

BOGUS CHINCH BUGS.

"Few things are more astonishing than the acuteness of perception superinduced by being constantly conversant with some one particular subject. I have often been surprised at the readiness with which nurserymen will distinguish between different varieties of Apple, even in the dead of the year, when there are no leaves, and of course no fruit on their nursery trees. In the same way old practiced shepherds can recognize every individual sheep out of a large flock, though, to the eyes of a common observer, all the sheep look alike. Experienced grain-growers, again, can distinguish at a glance between twenty different varieties of wheat, which the best botanist in the country would fail to tell one from the other; and I have been informed that a miller of many years' standing, as soon as he has shouldered a sack of wheat, knows at once whether it is Spring grain or Fall grain; while ninety-nine entomologists out of every hundred would probably be unable, on the most careful inspection, to tell the difference between the two, and some might even mistake wheat for rye.

"It is not surprising, therefore, that persons who have paid no particular attention to the study of insects, often confound together insects which, in the eyes of the professed entomologist, look as different from each other as a horse does from a cow or a hog. It would, indeed, be little short of miraculous if this were not so; for there are about thirty thousand distinct species of insects to be found within the limits of the United States, and of course in such a vast multiplicity, there must be many strong resemblances.

"I will therefore conclude this article on the Chinch Bug, by briefly mentioning several true Bugs, belonging to the same sub-order of Half-wing Bugs (*Heteroptera*), as that pestilent little foe of the farmer, and which I know to be frequently mistaken for it. The reader will then, by comparing the different figures, see at once how widely they all differ, and by a very little practice, his eyes will become so well educated that he will soon, without any artificial assistance from glasses, be able to distinguish the creatures one from the other, as they crawl or fly about in the almost microscopic dimensions assigned to them by their Great Creator.

"One reason, perhaps, why so many different bugs are popularly confounded with the Chich Bug, is the similarity of their smell. Everybody is aware that chinch bugs possess the same peculiarly unsavory odor as the common Bed Bug; and hence when a person finds a small insect that has this obnoxious smell, he is very apt to jump to the conclusion that it must be a chinch bug. No mode of reasoning, however, can be more unsafe or unsound. There are hundreds of different species of Half-wing Bugs—the common brown Squash Bug (*Coreus tristis*) for example—that possess this peculiar smell."

The False Chinch Bug.—This insect is most often mistaken for the genuine article, and letters like the following, received from a correspondent last Fall, are not uncommon, and relate to it:

[Fig. 9.]

False Chinch Bug:—*b*, pupa; *c*, mature bug.

I came across a (to me) curious thing the other day. I have allowed the purslane to grow in my strawberry ground this Summer, thinking to protect the plants from the sun somewhat. Lately we have been clearing it out, and I was much surprised to find under the rank growth millions of chinch bugs. They were not all in the perfect state (winged), but many not half grown. Can they be the real thing? They look like it, and certainly *smell* like it. But the wing-marks do not seem as distinct or broad, only five white lines crossing at an acute angle. Also, the young ones are not red, but ashen gray, and with bodies thicker and broader than the true grain bug. What were they there for? They would not feed on purslane, would they? and no other weeds were there. I found quantities of leaves and fragments of leaves on the ground; but the Chinch Bug is not an eater,

but a sucker, I suppose. If they were there to Winter, it would be advisable to rake it all off and destroy it in some way, but purslane dies hard as well as Chinch Bug. Coal oil, though, will kill him as quick as lightning.

As there is an account, with description, of this False Chinch Bug in my 5th Report, it is only necessary to say in this connection that the species is a very general feeder and in the Spring of the year does much damage to many plants, such as young grape-vines, strawberries, potatoes, young apple grafts, but especially to plants of the Cabbage family. It is especially fond of purslane, and at approach of Winter, congregates beneath it in immense numbers. Long after Jack Frost has blackened and deadened all but the very butts of the plants, these bugs may be found under them, running actively about whenever the sun is the least warm. They are found at this time of all ages, but principally mature and in pairs, and it is doubtful if any but the mature ones survive the Winter.

All the reports—and such come sometimes from noteworthy sources—of chinch bugs injuring herbaceous plants, vegetables and vines, owe their origin to the confounding of this, the bogus, with the true Chinch Bug; for though the latter may occasionally be found sheltering under purslane and other plants, it does not feed on any other than those already indicated.

THE INSIDIOUS FLOWER-BUG—Next to the preceding species, this little fellow, already referred to (p. 41, *ante*) as preying on the Chinch Bug, is quite often mistaken for it, having somewhat similar colors, and being so often associated with it.

THE ASH-GRAY LEAF-BUG—This species (*Piesma cinerea* Say, Fig. 10), is also often mistaken for the great American grain pest. It is a small greenish-gray bug, its size being about the same as that of the Chinch Bug, though it is flatter, broader, with shorter legs, and lacks altogether the conspicuous black and white markings which characterize that little grain pest, and really resembles it in nothing but the unpleasant odor which it emits. It has been found doing some damage to grape blossoms in early Spring, but is not otherwise very injurious, as it lives principally on forest shrubs and trees. The Ash-gray Leaf-bug belongs to an entirely different group (*Tingis* family) from the Chinch Bug, all the species of which have a short 3 jointed beak, which however differs from that of the 3-jointed beak of the Flower-bugs (*Anthocoris*) by being encased in a groove when not in use. They mostly live on green leaves in all their three stages,

[Fig. 10.]

ASH-GRAY LEAF-BUG.

after the fashion of plant-lice. Like the Chinch Bug, the Ash-gray Leaf-bug hibernates in the perfect state, and may be found in the Winter in considerable numbers under the loose bark of standing trees and especially under that of the Shag-bark Hickory. It also frequently swarms in the air, and I have gathered it by hundreds on top of one of the highest buildings in St. Louis, on a warm October day.

THE FLEA-LIKE NEGRO-BUG—Fourth among the bogus chinch bugs may be mentioned the Flea-like Negro-bug (*Corimelæna pulicaria*, Germar, Fig. 11). Its color is black with a white stripe each side.

[Fig. 11.]

FLEA-LIKE NEGRO-BUG.

This insect resembles the Chinch Bug in having an ordinary 4-jointed beak, but differs from it in belonging to a very distinct and well marked group (*Scutellera* family), which is characterized by the enormous size of the "scutel" or shield. This bug has a great passion for the fruit of the Raspberry, and is sometimes so plentiful as to render the berries perfectly unsaleable by the bed-bug aroma which it communicates to them, as well as by sucking out their juices. Wherever it occurs, the nauseous flavor which it imparts to every berry which it touches, will soon make its presence manifest, though the little scamp may elude ocular detection. It is really too bad that such a little black "varmint" should so mar the exceeding pleasure which a lover of this delicious fruit always experiences when in the midst of a raspberry plantation in the fruit season. It is also quite injurious to the Strawberry, puncturing the stem with its little beak, and thus causing either blossom or fruit to wilt. It also attacks both Cherry and Quince, occurring on these trees in very large numbers, and puncturing the blossoms and leaves, but especially the fruit stems, which in consequence shrivel and die. It is also quite injurious to garden flowers and especially to the Coreopsis, and abounds on certain weeds, among which may be mentioned the Red-root or New Jersey Tea-plant (*Ceanothus Americanus*), and Neckweed or Purslane-Speedwell (*Veronica peregrina*). In the month of June under these two last named plants, they may be found in countless numbers of all sizes and ages, from the small light brown wingless, newly hatched individuals, to the full fledged jet black ones. Though found on so many different plants however, it does not, like the true Chinch Bug injure, or in any way effect, our grasses and grains.

"To these four bogus Chinch Bugs, might be added one or two other species of small stinking bugs which have been, by some persons, mistaken for the true Chinch Bug. But enough has been already

said to show, that insects which in reality are shaped and fashioned as differently as are cows and deer, are yet often confounded together in the popular eye, principally, no doubt, because they have the same peculiar bed-bug aroma. Should the ignorance of the popular judgment in confounding these tiny creatures, which seem to the Entomologist so very, very different from each other, therefore, be despised and ridiculed? Far be it from me to display such intolerant stupidity! As well might the nurseryman ridicule the grain-grower because the grain-grower cannot distinguish a Baldwin Seedling from a High-top Sweeting; or the grain-grower the nurseryman, because the nurseryman cannot tell Mediterranean from Tea wheat, or Club from Fife. I do, however, entertain an abiding hope that by the present very general and praiseworthy movement toward the popularization of natural history, and by the dissemination of Entomological Reports, a better knowledge of this practically important subject will soon exist in the community. Our farmers will then, not so often wage a war of extermination against their best friends, the cannibal and parasitic insects, while they overlook and neglect the very plant-feeders which are doing all the damage, and upon which the others are feeding in the very manner in which a Wise Providence has appointed them to adopt."

RECAPITULATION.

While there is much more on this interesting subject to be said, the length this article has already assumed prompts me to bring it to a close; and I will recapitulate by giving a condensed statement of the more important facts relating to the Chinch Bug:

The Chinch Bug injures by suction, not by biting.—It winters in the perfect winged state, mostly dormant, principally in the old rubbish, such as dead leaves, corn-shucks, corn-stalks, and under weeds and prostrate fence rails and boards that generally surround grain fields; also, in whatever other sheltered situation it can get in adjacent woods: hence the importance of fighting the pest in the Winter time, either by trapping it under boards laid for the purpose, or by burning it with its afore-mentioned shelter. Such burning will not destroy all the dormant hosts, but will practically render the species harmless—especially where whole communities combine to practice it.—It issues from its Winter quarters during the first balmy days of Spring, when those females which were impregnated the previous Fall, and which are most apt to survive the Winter, commence ovipositing

at once, if suitable conditions are at hand. Others take readily to wing and scatter over our fields, attracted by preference to grain growing in loose and dry soil, into which they penetrate to consign their eggs.—The eggs are deposited on the roots, and the young bugs, which are red, remain under ground, sucking the roots during the early part of their lives, or until they are forced from necessity to travel from one plant to another. These Spring-hatched bugs, constituting the first brood, do not, as a rule, acquire wings till after wheat is cut. It is, therefore, during and just after wheat harvest, that they congregate and travel in such immense swarms as to attract attention.—In July, as these acquire wings, they scatter over grass, late grain and corn-fields, where they lay their eggs; but the second brood, hatching from these eggs, generally attracts less attention and does less injury than did the first, because of its more scattered nature and the greater maturity and resisting power of the plants.—Anything that will prevent the mother bug from getting at the roots of the grain, will prevent the injury of her progeny: hence the importance in this connection of Fall plowing and using the roller upon land that is loose and friable; and hence, if old corn ground is sufficiently clean, it is a good plan to harrow in a crop of small grain upon it without plowing at all. The earlier, also, that wheat gets well started and matures, the less it will suffer; because it may be harvested before the bugs acquire their greatest growth and power for harm: hence, and from the greater compactness of the ground, Winter wheat suffers less than Spring wheat.—Heavy rains are destructive to the Chinch Bug: hence, if such occur in the Fall, the farmer may plant with little fear of injury the following year, while if they occur in May, he need suffer no anxiety, so far as chinch bugs are concerned: hence, also, where irrigation is practicable, the pest may at all times be overcome.—It injures no other plants than grasses and cereals.—In its migrations from field to field it may be checked by a line of tar poured on the ground, or by deep furrows or trenches, but the tar must be kept soft and the surface of the furrows friable and pulverized.

APPENDIX

TO THE

ARTICLE ON THE CHINCH BUG.

To publish entire all the answers to the questions in the circular sent out over the State would be an unnecessary waste of space; and I have, in this Appendix, endeavored to condense as much as possible without omitting any statistical facts or experience in any way valuable. In order to save space and avoid repetition, I give the returns by counties, signed by the initials of the correspondents, and preface by a list of the gentlemen who have favored me with replies and to whom I hereby tender my sincere acknowledgments. From the counties following which there are no names, reports have failed to come to hand; while a number of replies are unrecorded, because they came to hand without the postoffice address or the county being indicated. In some counties, as St. Louis, I have been able to make personal observations.

LIST OF CORRESPONDENTS WHO MADE RETURNS.

ADAIR—E. M. C. Morebeck, * *; John S. Erwin, Kirksville. ANDREW—J. H. Smith, Whiteville; Jacob Kimbertin, Rochester; R. H. Talbot, Bolckow; John White, Flag Spring. ATCHISON—B. Bond, * *. AUDRAIN— — — BARRY—S. M. White, Washburn; W. F. Tuttle, Hazle Barrens. BARTON—A. A. Dye, M. D., Lamar; J. J. Bryning, Doylesport; W. H. Avery, Lamar. BATES—W. R. Thomas, Lone Oak; G. B. Hickman, Mulberry; Addie Haynes, Rockville. BENTON—J. A. Hughes, * *; James H. Lay, Warsaw; W. F. Joplin, Lincoln; J. H. Maxwell, Mt. View; J. M. Murress, Windsor. BOLLINGER— — — BOONE—J. B. Douglass, Columbia. BUCHANAN—M. W. Farris, Agency; J. P. Reichard, St. Joseph. BUTLER—Albert Ponder, Freddie; John M. Allen, Cane Creek. CALDWELL—C. L. Gould, Hamilton; D. W. Monroe, Kidder. CALLAWAY— — — CAMDEN— — — CAPE GIRARDEAU—Henry Bruihl, Appleton; H. G. Wilson, Cape Girardeau; R. H. Burford, Burfordsville. CARROLL—H. S. Hall, Van Horn. CARTER— — — CASS—W. H. Barron, Raymore; H. L. Hewitt, Austin; P. C. Homey, * *; D. Defahaugh, Harrisonville; W. A. Smith, East Lynn; J. L. Kanaga, Raymore. CEDAR—E. W. Montgomery, Cane Hill; C. N. Jordan, Whitehare; W. Smiley, Stockton. CHARITON—R. Fox, Westville. CHRISTIAN—R. P. Lawing, Ozark. CLARK—B. P. Haman, Clark City; D. H. Lapsley, Kahoka. CLAY—G. T. Odor, * *; Dan. Carpenter, Barry; J. C. Evans, Harlem. CLINTON—A. J. McCrayner, Plattsburg. COLE—Frank M. Dixon, Jefferson City. COOPER—W. R. Baker, Lone Elm. CRAWFORD—James Asher, Clinton Mills; M. O. Taylor, Bourbon, DADE—Ross A. Workman, Greenfield. DALLAS—G. A. Howerton, * *; M. L. Reynolds, Buffalo. DAVIESS—Israel Coen, Jamesport; G. D. McDonald, * *; W. W. Woodbridge, Jamesport; L. Dowell, Bancroft. DEKALB—Horatio Morris, Winslow; G. E. Shulz, Havana; W T. Wallingford, DeKalb. DENT— — — DOUGLAS—W. Pryon, Pryon's Store. DUNKLIN—W. G. Bragg, Kennett. FRANKLIN—F. W. Pehle, New Haven; S. Miller, * *. GASCONADE—Henry Read, * *. GENTRY—A. J. Clark, Gentryville; Levi

Long, Mt. Pleasant; Charles S. Whitescarver, Mt. Pleasant; Hugh Stevenson, Gentryville; W. H. Rogers, Alanthus; H. W. Johnson, New Castle; J. A. Mauring, Havana; Elisha Brace, Sampson Creek; James Shillingham, * *. GREENE—S. A. Edmonsom, Walnut Grove. GRUNDY—Val. Briegel, Trenton; G. H. Hubbel, * *. HARRISON—J. Whiteley, New Castle; Col. H. Fitch, Eagleville; J. H. Burrows, Cainsville; Sam. McCray, Mitchellsville; C. F. Fransham, Yankee Ridge; Wm. Rakestraw, Bethany. HENRY—D. C. McIntire, Norris Fork; J. E. Stringer, Leesville; T. J. Quick, Gaines. HICKORY—W. L. Snidow, Elkton; James W. Dickerson, * *; C. J. Hostetler, Wheatland. HOLT—Bennet King, * *; J. W. Crow, Bigelow; W. Kaucher, Oregon; J. D. White, Forest City; J. W. Maple, Oregon. HOWARD—Garnett W. Morehead, Glasgow. HOWELL— — — IRON—W. Cam, Belleview. JACKSON—Dr. John L. Gregg, Stony Point; W. S. Parrish, Hickman's Mill; J. W. Geiger, Hickman's Mill; J. A. Moore, Pink Hill; W. J. Gault, New Santa Fee. JASPER—J. M. Peterson, Preston; W. G. L. Craig, Smithfield; J. U. Thornburg, Reeds; Thomas McWallie, Avilla. JOHNSON—W. Campbell, Holden; J. L. Cleland, Chalybeate; Dr. Dunkly, Dunksburg; D. B. Reavis, Kingsville; E. J. Coleman, * *; J. Milo Martin, Pittsville; J. L. Motsinger, Fayetteville. KNOX—Jac. Wingerter, Millport. LACLEDE—L. R. Rupart, Hazle Green. LAFAYETTE—James Belt, M. D., Napoleon; J. J. Ferguson, Sniabar; James E. Gladish, Aullsville. LAWRENCE—W. L. Goodman, Mt. Vernon. LEWIS—W. B. Dement, Bunker Hill. LINCOLN— — — LINN—A. Moyer, Brookfield. LIVINGSTON— — — MACON—W. B. Martin, College Mound. MADISON—Joseph M. Anthony, Fredericktown. MARIES—D. L. Dodds, Vienna. MARION—J. K. Martin, Philadelphia; W. R. Anderson, Palmyra; Rufus M. Brown, Palmyra; S. F. Taft, Hannibal. McDONALD—W. D. Palson, Southwest City. MERCER—J. H. Burrows, Cainsville. MILLER— — — MISSISSIPPI—S. S. Smith, Bertrand. MONITEAU— — — MONROE—J. P. Myers, * *. MONTGOMERY—D. T. Mitchell, Jonesburg; E. R. Brown, Montgomery. MORGAN— — — NEW MADRID—James S. Barney, New Madrid. NEWTON—John Thrasher, Neosho; W. H. Wetherell, Seneca. NODAWAY—W. B. M. Harman, Pickering; W. Pittman, Marysville; W. H. Clark, Luteston; T. D. Wallace, Hopkins. OREGON—J. R. Woodside, Thomasville. OSAGE—Lucien Philbert, Dauphine. OZARK—James Price, * *; T. J. Gideon, * *. PEMISCOT— — — PERRY—R. M. Brewer, Perryville. PETTIS—Elihu Canaday, Ionia; L. H. Williams, M. D., Houstonia; O. A. Crandall, Sedalia; C. R. Hoag, Sedalia. PLATTE—James Adkins, Platte City; R. P. C. Wilson, Platte City. POLK—T. W. Simpson, Payne's Prairie; M. D. Mitchell, Morrisville; John Carson, Bolivar; H. M. Wallard, Humansville. PULASKI—Charles Curtis, Dundas; O. J. Ryther, Iron Summit. PUTNAM—A. D. Thomas, Terre Haute. RALLS—A. E. Trabue, Hannibal. RANDOLPH—W Quayle, Moberly. RAY—* *, Morton. REYNOLDS— — — RIPLEY—B. Hassell, Doniphan. ST. CHARLES—C. Weinrich, New Melle. ST. CLAIR—S. H. Long, Taborville; W. H. Fillery, Collins; C. A. Schooley, Taborville. ST. FRANCOIS—E. H. Perkins, Farmington; F. E. Clay, * *; A. J. Leathers, Farmington. STE. GENEVIEVE—J. R. Prichard, Bloomsdale. ST. LOUIS— — — SALINE—Jno. P. McManus, Lutesville. SCHUYLER— — — SCOTLAND—Albert North, Memphis. SCOTT—H. P. Lynch, M. D., Commerce. SHANNON— — — SHELBY—John B. Randal, High Prairie Home. STODDARD— — — STONE— — — SULLIVAN—Sumner Boynton, Milan. TANEY—J. J. Brown, Forsyth; W. R. Howard, Forsyth. TEXAS—R. S. Smiley, Houston; George A. Bezoni, Roubedoux. VERNON—M. L. Modrel, Little Osage; J. A. Princeton, Schell City. WARREN—D. P. Dyer, Warrenton. WASHINGTON—W. Riehl, Potosi. WAYNE— — — WEBSTER— — — WRIGHT—E. B. Griffin, Hartville. WORTH— — —

QUESTIONS ANSWERED BY CORRESPONDENTS.

1. How far back in the history of your county has this insect been known to injure the grain and grass crops?

2. What crops have suffered most from its ravages?

3. Have any systematic efforts ever been made to overcome its injuries? and have you any idea to what extent my Second Report—which contained all that was known about the insect up to that time, and which was bound in with the Fifth (1869) State Agricultural Report—is distributed or known of among the farmers of your county?

4. Give approximately this year's estimated damage in your county, by this single insect—all crops affected by it considered.

The answers, here following, are numbered to correspond with the questions. Those to questions **1** and **2**, which have been summed up on pages 22, 23, 26 and 27, and which are very similar, are almost entirely omitted.

Adair County.

3—No systematic efforts have been made to overcome them. I know nothing of your Second Report; have never seen one.—E. M. C. M. The only attempt to check them has been by plowing a furrow and dragging a log in it. They have sometimes been prevented from passing from grain into corn by this means. I believe very few here have seen the report to which you refer.—J. S. E.

4—I cannot arrive at anything like a correct report for this year. In some locations whole fields of corn, especially late planting, oats and Spring wheat. The last named grain we hold to be the nursery of the Chinch Bug.—E. M. C. M. I believe that 20,000 dollars is a moderate estimate of the damage to crops in this county for the present year.—J. S. E.

Andrew County.

3—None have been made.—J. H. S. No preventives found against them.—J. K. None. Your reports do not get into the hands of many farmers.—R. H. T. None. I have no knowledge of your report on that insect.—J. W.

4—The corn crop has been damaged this year at least one-half.—J. H. S. I should estimate that the damage done this year by these bugs would amount to fully ($40,000) forty thousand dollars.—R. H. T. About 33 per cent.—T. W.

Atchison County.

2—The crop of this year principally injured by Chinch Bug is the corn crop, as they made their appearance too late for small grain.—B. B.

3—No systematic effort has been made to overcome its injuries; but very few copies of your Second Report were distributed among the farmers of this county.—B. B.

4—The damage to the corn crop is fully one-third to one-half, and they are still, to this date (December 24), alive in all protected places.—B. B.

Barry County.

1—The Chinch Bug has never been known in the county or in this section of country prior to the Summer of 1874.—S. M. W. It never was known in this county until this Summer.—W. F. T.

3—No systematic effort has ever been made to overcome its ravages and injuries. I do not know, neither can I learn, of your Second Report being distributed among the farmers.—S. M. W. Nothing has been done to overcome its injuries. I know nothing about your Second Report, but would like to see it.—W. F. T.

4—The wheat was not hurt to any great extent, as it was ready to harvest before they made their appearance in any very great quantities. Corn—late corn—in some localities was ruined. Hereabouts corn was not seriously injured as it was large and forward at the time of wheat harvest. Probably 10 per cent. would cover the whole amount of damage done to all crops. * * * —S. M. W. The damage done in this county was fully one-half of the crops of corn and sorghum, and the entire crop of Hungarian grass and millet, which would amount to many thousands of dollars.—W. F. T.

Barton County.

3—Yes. Some have sown Hungarian grass between wheat and corn, for it seems to be in the wheat-fields that the first crop is hatched. Some neighborhoods have not sown any wheat at all. After the first crop has hatched in the wheat, they plow around the field or keep continually running a roller around it so as to crush them. This seems to keep them back for a week or two. When they get large enough to fly, they leave the wheat-fields and scatter in all directions, where they lay their eggs and hatch out the second crop. * * * —A. A. D. No. Said Report has been seen and known comparatively little.—J. J. B. No efforts have been made to overcome its injuries. I do

not think your Second Report is at all known or distributed among the people of this county. To-day, I inquired at every place in town where I might expect to find it, but could not. Nor could those most likely to know tell me anything of it.—W. H. A.

4—On account of our extreme drouth here the last season the Chinch Bug did more than its usual amount of damage—probably $100,000 worth.—A. A. D. Any estimate of said damage would be hard to make, approximating the truth, without a vast deal of trouble, as our wheat was affected some, but chiefly because of the drouth, and oats almost a failure from the same cause. True, both suffered some from the bug, and as to the corn crop in our county, perhaps not one-sixth of an average crop was harvested ; one-half of which might be owing to the prevalence of the bug—that is to say, without either bug or drouth, and *with* either alone three times as much could have been raised. Our wheat crop was better than an average since '68.—J. J. B. Cannot estimate the damage from this source this year, as it is impossible to say how much is attributable to the drouth and how much to the bug. Some farmers think they would have had much better corn if it had not been for the bug, but as they raised almost *none*, it is a doubtful question.—W. H. A.

Bates County.

1—The corn crop has suffered most the past season from their ravages. * * * The first crop was not two-thirds grown at the time of wheat harvest. They commenced to fly July 20th and settled all through the corn-fields, but the greatest injury was done by the second crop in the latter part of August and first of September. We think the third crop of them was hatched the first of October, but are inclined to think not many of them came to maturity as we find them dead on the corn-stalks now not more than half grown. * * *—W. R. T.

2—This year for the first time farmers showed some fight. * * *—W. R. T. No efforts have been made to overcome its injuries that have availed any thing; plowing them under and dragging logs, etc., is all that has so far been done. Your reports, on inquiry for them, I find have never been distributed at all among the farmers, and, in fact, I cannot find a copy in the county.—G. B. H. The heat was so intense for several days during the middle of August, that by pulverizing the ground to fine dust and then shaking them from the corn into it, they would roast in half a minute. We are convinced that not more than half a dozen farmers in this county ever received a copy of the Agricultural Report for 1869; in all probability it was more freely distributed among lawyers, merchants and doctors, than farmers. We applied for a copy but never received one.—A. H.

4—There was more wheat sowed this year than ever before in my circle of acquaintance, and while some raised a little wheat many never raised a bushel; if the county raised the seed it is all it has done. Oats were nearly destroyed. * * * The corn crop will not average more than five or six bushels per acre, and as I am not posted with regard to the number of acres in cultivation in Bates county, I am unable to make anything of a correct estimate, but the damage would be fearful.—W. R. T. The damage by this insect in our county this year is impossible to state as we have almost a total failure, and the whole of it is due to Chinch Bug; nothing escaped it in the shape of grain or grass. * * *—G. B. H. We estimate the damage done by this insect alone in this county at not far from one million dollars.—A. H.

Benton County.

3—No efforts made. Your Second Report is not known here.—J. A. H. No systematic efforts have been made against them. A little desultory plowing of furrows is all that has been done. I have never heard of a copy of your Second Report in the county. I desire a copy.—J. H. L. There are no systematic efforts being made to overcome its injuries. I do not think your Second Report is very generally known or distributed among the farmers of Benton county.—W. F. J. No systematic efforts have been made. Don't know anything about your Second Report.—J. H. M.

4—The corn crop was probably damaged 45 per cent. by the bugs and 45 per cent. by the drouth, leaving us about 10 per cent. of a good crop. Our wheat being mostly in the timber was not badly damaged. Inferior wheat crops on the prairie were completely destroyed. Good ones escaped with little damage. * * *—J. H. L. It would be an impossibility to give any correct estimate of damage by its ravages, as the Chinch Bug and dry weather together have caused almost an entire failure in this county.—W. F. J. The damage done by this single insect in our county the past season is so great that I cannot give an estimate.—J. H. M.

Boone County.

4—I cannot approximate the estimated damage in my county.—J. B. D.

Buchanan County.

3—None that I know of. I have no idea that more than one-tenth of the people in this county ever heard of the Report.—M. W. F.

4—The estimated damage would reach several thousand dollars. Have no way of making a correct estimate with me at the present time.—M. W. F..

Butler County.

3—There has been no effort made for their destruction. I have no idea how far your Report has been distributed.—A. P. None.—J. M. A. One-half the crops are destroyed this year.—J. M. A.

Caldwell County.

2—Corn was injured worst, wheat next, oats least; Spring wheat ruined. I believe that the chinches killed new seeding of grass, especially when sowed on wheat or oats ground.—C. L. G.

3—None. Have never seen it, and cannot tell to what extent it has been distributed.—D. W. M. There are in this county 432 sections of land. I estimate one-eighth of the land in the county was planted in wheat and corn, which at $2.00 damage per acre, would give about $70,000. Add to this amount nearly as much more damage, caused by farmers being obliged to sell their hogs and cattle without fattening, (and I am satisfied this is the actual fact): I therefore estimate the whole damage done by chinch bugs in Caldwell county at $125,000. I remember that one year in Wisconsin they were so numerous that in their migration they fell into Lake Michigan, and washed ashore in such quantities as to make a stench along the beach. If this shall be of any use to you in your good work, I shall be amply rewarded.—C. L. G.

Cape Girardeau County.

3—No remedies have been tried that seem to be effective.—R. H. B. No, I think not. Some farmers are talking about burning off the stubble-fields and burning the woods lands, but they do not agree very well about it. I had a field of heavy wheat stubble burned by accident the past Summer, in which there were a few bugs. I shall notice the result next year. I have practiced Fall plowing since I have been farming, and I rather think that it keeps the bugs in check. I have in mind one field that was in corn three years ago, when the bugs first appeared; it had been plowed the Fall before. My neighbors' fields were troubled with bugs that year but this field was not. It was again plowed in the Fall and put in oats in March following, and if there were any bugs in the oats I did not discover them. The oats were taken off in July, the ground immediately plowed and sowed to Hungarian grass. The grass was taken off the 1st of September, the ground immediately plowed, and first of October replowed and sowed to wheat. A good crop of wheat wast taken off last June, the ground plowed in July and again first of September and sowed to grass for meadow. It is now green all over the field, and if that field has ever had any chinch bugs in it I have failed to find them. On the opposite side of a lane lies another field having about the same fertility (rich bottom)

and separated by a public road and fences. The latter field was sowed to barley in September, 1873—harvested in June last year. The crop was light—only 25 bushels per acre, when it should have produced 40. I did not know even at harvest, that the chinch bugs were the cause of the short crop. This barley stubble was plowed as quick as the grain could be taken off, and on the first of July the ground was nicely planted with sprouted corn. The corn came up quickly—the ground being rich it grew fast and had a dark green color—but when about eight or ten inches high, I noticed that the bugs were thick on it. It seemed to withstand the effects of the bugs until four feet high, when it was then attacked by a kind of cut-worm of a green color, and the chinch bugs and the worms together completely ruined it. I would like to know more about this worm. (Probably the Fall Army-worm; see 3d Rep.) I hope you will excuse this digression. I have stated facts—they may be of some use.—T. O. Your Second Report has not been distributed in this section of the county.—R. H. B. No efforts that I am aware of, systematic or otherwise, have been made to overcome its ravages, except that it has perhaps induced somewhat earlier planting. Your Second Report alluded to, has not been distributed or known among the farmers of this county, except perhaps a few that may have been distributed by the members of the Legislature.—W. C. R. All crops considered, I should think it would be from $30,000 to $40,000.—H. G. W.

Carroll County

3—No systematic efforts have been made to destroy it. Your Second Report referred to, is not very generally distributed among the farmers, and very little is known of it. Like many other similar documents, it helps to fill up the lank libraries of landless lawyers and impecunious country editors. A State Senator has promised me a set of State Agricultural Reports for the library of Van Horn Grange, (now numbering 125 volumes) but I presume the promise will be forgotten.—H. S. H.

4—I have no data from which to estimate the money damage, but the wheat was badly shrunken, and three-fourths of the corn crop entirely destroyed this year by the chinch bugs. Dry, hot weather is favorable to its development. In wet seasons it does very little damage, * * *.—H. S. H.

Cass County.

3—(All the correspondents agree in stating that no systematic efforts have been made; and that little or nothing is known of my Second Report.)

4—Five hundred thousand dollars would be a low estimate of the amount of damage done by this pest in Cass county this year.—W. H. B. It is impossible to even approximate an estimate of damages. They injured Spring wheat and barley to such an extent that there has been no attempt for several years to raise either. Winter wheat was not injured as much in 1874 as in some previous years. Oats crop reduced at least 40 per cent. Corn (the principal crop cultivated) was injured to such an extent by drouth and bugs that the south half of the county will not average over ten bushels per acre, and that of *very* poor quality—principally chargeable to the bugs, from the fact that occasional fields more favorably situated, (by being partly or altogether surrounded by timber, at greater distances from fields of small grain, etc.,) made a fair average yield regardless of drouth. * * * —H. L. H. Can't make an estimate of the amount of damage done in the county this season. It was immense. They reduced the wheat and corn crop from one-fourth of an average yield to an *entire* failure.—P. C. H. The damage sustained by them in Cass county this year was fully 50 per cent.—D. D. The amount of damage in this county is enormous. Corn nearly ruined, wheat and oats badly damaged.—W. A. S.

Cedar County.

3—(All the correspondents state that plowing and ditching and dragging were alone resorted to; and that nothing is known of my Second Report.) I can't say just

how much we were damaged by the Chinch Bug; they ate about two-thirds of our crops clean. The farmers in this county are going to have a hard time to get through the winter.—E. W. M. They destroyed about one-third of the wheat crop, three-fifths of the corn crop, one-half the oats and Hungarian, and one-half the sorghum.—W. S.

Chariton County.

3—There never has been any effort made to destroy it, but I think it is high time that we make an effort in that direction. I do not think there is a farmer in my neighborhood that ever saw your Second Report or ever knew anything about it.—R. F.

4—It is impossible for me to give anything like a correct estimate of the damages done by this insect during the past season, because we had a protracted drouth which commenced with the bugs and lasted through the entire growing season. Spring wheat was totally destroyed, and none but the early Fall wheat escaped its ravages, and I think there is scarcely a stalk of corn in all the western, northern and northeastern portions of this county that has not suffered more or less from this pest; and owing to the drouth and Chinch Bug combined, there was not five bushels of corn raised to the acre, taking the county over.—R. F.

Christian County.

4—The bugs cut off our corn on an average about six to seven bushels to the acre. —R. P. L.

Clark County.

3—No systematic efforts to prevent their ravages. I think your reports are not much known in Clark county.—B. P. H. No efforts have been made to overcome their injuries. You have my thanks for your Sixth Annual Report. I have failed to get hold of your former reports.—D. H. L.

4—Probably $20,000 or more. Many crops of Spring wheat and barley were entirely destroyed, and corn near such fields was badly injured by the bugs after leaving the small grain. They seemed also to breed in the corn in August and September, and caused a great deal of corn to shrivel while in roasting ear.—B. P. H.

Clay County.

3—No; neither systematic or spasmodic. I do not think your Report of 1869 is in the hands of one farmer in fifty, and I doubt if one in a hundred has ever seen it.—D. C. We do not think your Second Report was known of in our county, except in our immediate neighborhood, where it was distributed by our Missouri Valley Horticultural Society—J. C. E.

4—Corn was cut off one-third, oats nearly as much; wheat was damaged but little, it was too early for them.—G. T. O. Cannot give even a guess at the damage. I know some oat-fields yielding nothing, some wheat not over one-half crop, corn-fields the same, and thus graduating up to no injury at all—D. C.

Clinton County.

3—None. However, a few farmers burned their wheat-fields instead of trying to harvest them.—A. J. M'C.

Cole County.

3—No systematic effort has been made, as far as I can say, to checkmate the ravages of this pest. To what extent your Second Report has been distributed, I would say, to the best of my belief, not very extensively; nor do I believe such reports ever will reach the class of men they are intended for unless other ways are devised to distribute them more widely and with more certainty.—F. M. D.

Cooper County.

3—No systematic efforts have been made. * * * Your Second Report I do not think is distributed to any extent among the farmers of this county. I think the wheat and corn crop injured to at least one-fourth their value.—W. R. B.

Crawford County.

3—There has been no effort, only to sow early; this has saved the wheat crop this year. I have not seen one of your reports in the county.—H. A. There has been no systematic effort made to overcome its injuries to my knowledge.—M. O. T.

4—Wheat, none; oats, one-half; corn and grass the same.—J. A. I have endeavored by conversation with farmers and others in different parts of the county to obtain something near the amount of damage done by the Chinch Bug this year, but am unable to arrive at anything definite; suffice it to say it is thousands of dollars. * * * —M. O. T.

Dade County.

3—No. Individual efforts, such as plowing out a trench and dragging a log in it, or burning trash in it. Keeping a strip of fallow land between infested crops and those not infested, also planting objectionable crops, such as castor beans, between wheat and corn, has been tried, but with no very encouraging success. Your Second Annual Report is unknown to the farmers of this neighborhood. I have sought for it in vain.— As to my own experience, I find that enough chinch bugs do not winter over on my place (two miles from timber) to seed it in the Spring. But every Spring, soon after the earliest corn is up, they come in on the wing before the wind, and take possession of, and lay their eggs on, every green thing that suits their purpose. At the same time that the eggs hatched out in the wheat, they also hatched out in the early planted corn, while there were none in the corn and Hungarian planted and sown after the Spring invasion, until they were driven out of the wheat and oats by the harvesters. In these Spring migrations they always come from the same direction—southwest before a southwest wind, and apparently from a strip of timber on Horse creek, about three miles away. According to this, trenching, etc., will do very well for late crops, but is of no use for those crops that are up before the Spring migration, which occurred last Spring, as nearly as I can recollect, the first week in May, and all over the county at the same time. I believe that if we can get a good game law, absolutely prohibiting the trapping and netting of quails and prairie chickens, and then make the farmers see that it is to their interest to have it enforced, we will be injured no more by the Chinch Bug.—R. A. W.

Dallas County.

3—One of the most successful means employed is the following: As soon as you cut a piece of wheat or oats you will find they begin to migrate the same day to the adjoining crop, then you have your base of operation. Either haul straw, litter or something that will afford them shade, and about 2 or 3 o'clock P. M. you can, by burning the straw, burn millions of them. * * *—M. L. R.

4—Enormously; past my calculation. Have never seen a copy of your Second Report. Such documents are generally sent to lawyers, politicians, officers and professional men, who never read, much less make practical use of the valuable knowledge contained in them. I have often seen piles of such valuable books lay in our postoffice for months addressed to such persons. * * *—G. A. H. I am sure I will not make an overestimate of damage by the bug in placing it at $50,000.—M. L. R.

Daviess County.

3—During the last Summer, 1874, as soon as the wheat straw became dry the chinch bugs marched out of the wheat and into the corn; they went and blackened every stalk of corn for fifteen rows deep and next to the wheat. When I discovered this I took a large kettle and placed it near the Chinch Bug operations, filled it with water and went to work on them like some of our good house wives wage war on another insect that carries the same kind of odor. I thus cooked them by the millions. This ended their work of destruction in the field; the scalding did not destroy the

corn, as it continued growing and produced good sound ears of corn.—J. C. None. I do not think there are ten farmers in the county that have ever seen your Report of 1869, or any other year. I have never had one in my possession until the last one you sent me. Through the kindness of our then Circuit Clerk, I had the privilege of reading your Report for 1869 in his office. I never had one to read and study as I would like to have done and to refer to when I needed information from it. I was once in the clerk's office where I saw a number of volumes of the Report. I asked the deputy Clerk if they were intended for distribution? He replied that the names of the persons whom they were intended for were written on them by our Representative. I looked over them and found but one farmer's name, and he a former Representative and more politician than farmer. * * * —G. D. M'D. There have been no systematic efforts made to overcome its injuries. Right here comes a difficulty: the majority of farmers are more disposed to growl at their enemies than to grapple with them; it being much easier to wait than to work. I often wonder that such men as yourself and others, who are doing so much to enlighten and benefit the farmers, do not become discouraged and disheartened. Permit me to remark, however, that the better class of farmers do appreciate their efforts. The State Agricultural Report for 1869, or any other year, has not been distributed in this county; if there are any copies of such reports in the county they must be in the hands of some judge or lawyer. I should be very glad to know how to obtain such reports.—W. W. W. No systematic efforts have ever been tried to overcome its injuries, and your Second Report is but little known or distributed here. A few copies of your Annual Report distributed in this county would do much good.—L. D.

4—Owing to the drouth and the chinch bugs we have not one-tenth part of an average crop of corn. It was the only crop seriously injured by them, though I heard of some fields of wheat and oats entirely destroyed by them.—G. D. M'D. Spring wheat and sorghum totally destroyed; corn, from one-third to one-half; oats, one-quarter; Winter wheat, one-sixth.—W. W. W. The exact amount of damage done by this insect can not be determined, but it will probably exceed $400,000 this year.—L. D.

DeKalb County.

3—Your reports are not known in this county.—H. M. None. Your Report spoken of has not been distributed in this section among reading and thinking men. I have heard of a few copies in the hands of a few political favorites of that day.—G. E. S. No efforts have been made to counteract their ravages, and your Second Report is not in the hands of but few, very few, of the farmers of this county.—W. T. W.

4—Destroyed three-fourths of our corn crop.—H. M. Damage to all crops about 35 per cent. this year.—G. E. S. The damage has *not been nearly* so great in the timbered lands as compared with prairie lands.—W. T. W.

Douglas County.

3—No efforts have been made. I have no idea to what extent your Second Report was distributed among the farmers.—W. P.

4—I estimate the damage from this pest, all crops considered, at 35 per cent.—W. P.

Franklin County.

3—None.—T. W. P. I am not aware that any systematic efforts have been made to overcome its injuries, except in sowing such varieties of wheat as ripen early. It has been found that early maturing wheat is almost or entirely free from its ravages. I do not think that your Second Report has been distributed among the farmers of this locality.—S. M.

4—Chinch bugs have damaged this county from 80 to 100,000 dollars for the year 1874.—F. W. P. I believe 10 per cent. would be inside the damage done to all crops in this county by the Chinch Bug this season.—S. M.

Gasconade County.

3—No systematic efforts have been made for their destruction. Your Report is almost unknown in our midst; I managed to get one copy.

4—The estimated loss on corn and wheat occasioned by these bugs during the year 1874 will probably reach $55,000 or $60,000. The loss on sugar cane is not known, say $3,000 or more, as they are particularly fond of it; sometimes destroy the whole crops.—H. R.

Gentry County.

3—There has been no settled plan among the farmers to check the ravages of the bug. Your Second Report has never been circulated in this county.—A. J. C. None. Nothing known of your Second Report.—L. L. No effort made to overcome its injuries. Don't know of a copy of the Agricultural Report for 1869 in the hands of a farmer.—H. S. No systematic efforts have been made. Have never heard of your Report.—W. H. R. No. —. It is not in this part of the county.—H. W. J. No systematic efforts were made. Your report is little known.—J. A. M. No. Never saw it.—E. B.

4—I could not pretend to approximate the losses. They were terrible.—A. J. C. The damage this year has been very great; at the least value fully one-half of the corn and nearly all the Spring wheat and a great portion of the Fall wheat was ruined.—L. L. They have destroyed at least nine-tenths of the Spring wheat, one-sixth of the Fall wheat and one-sixth of the corn; oats, one-tenth.—W. H. R. This year's crops were injured 30 per cent.—J. A. M. Cannot do it, but will inform you that all Spring wheat was destroyed, and also one-quarter of corn.—E. B. The past Summer they destroyed nearly all the Spring wheat, many fields having never been cut, while many fields that were cut did not pay for the cutting. Hungarian grass suffered in about the same ratio as Spring wheat. Corn was badly damaged in places, slightly in others.—J. S.

Greene County.

3—None, except to plow ditches between the wheat and corn and drag a log in them. Don't know of a farmer that has one of your Reports.—S. A. E.

4—Corn five-tenths lost; wheat but little damaged; oats and hay one-half lost.—S. A. E.

Grundy County.

3—No systematic efforts have been made, and your Report is but little known. It is the general practice here to put out large corn crops, cherish great expectations, and see them devoured by these hungry pests. Spring barley is doomed to certain destruction, and no inconsiderable amount of wheat is thus annually lost. I have, indeed, sometimes heard farmers advocate clearing fence corners and burning corn-stalks to give them nothing to Winter under, but always concluding that as long as the rest don't fall in it is perfectly useless to trouble themselves about it.—V. B. No. Your Report is little known; say 10 copies in county.—G. H. H.

4—The average damage sustained by the corn crop was at least 60 per cent.; of the wheat crop about 25 per cent.—V. B. $50,000 is a moderate estimate. The corn crop was nearly ruined by them.—G. H. H.

Harrison County.

3—No. Not distributed among farmers generally.—C. H. F. No. Very little, I think.—J. H. B. None have been made. Your Report is not known in this neighborhood.—S. M'C. To my knowledge, none have been made. My idea is that if any of your Reports of 1869 were sent to this county, they were distributed amongst the merchants and mechanics, and not among those that would be benefited by getting them. —C. F. F. None have been made, and your Report is not much known among farmers. —W. R.

4—The damage this year to all crops has been 25 per cent.—J. W. Not so bad this year as in some other years.—J. H. B. They commenced later last Summer than usually, and worked later in the Fall. They did not damage Winter wheat very much, but cut the corn crop fully one-half short.—S. MCC. Spring wheat, in many places, entirely destroyed; cane damaged one-fourth, and corn, from chinch bugs and dry weather, not half a crop. Many claim that the bugs did more damage than the dry weather.—C F. F. They took half the corn crop, all the Spring wheat, half the young meadows damaged.—W. R.

Henry County.

3—(All three of the correspondents unite in the statement that no systematic efforts have been made, and that they have seen nothing of my Second Report.)

4—The damage done by Chinch Bug and drouth cannot fall short of one million of dollars.—D. C. M'T. It would be a difficult matter to give an estimate of the damage caused by them here this year, as no one escaped entirely and large fields of grain were destroyed —J. E. T. They and the dry, hot weather ruined our corn almost entirely, and oats also, so that we have not seed of either, and the most of us think of quitting small grain. * * * If we have another dry season like last year we are ruined, for there are plenty of people here now that have next to nothing to live on or to keep their stock with.—J. J. Q.

Hickory County.

2—Corn crops suffered most from its ravages, although old bugs that lived through last Winter, and there were legions of them that did, commenced their work in destroying the young growing wheat in early Spring, and some fields of wheat were totally destroyed by them before the wheat got in bloom, and by the time the corn was in silk and tassel, it was covered alive with the little devils; and fields of corn that were near or adjoining to wheat-fields, were killed dead by the time it was half leg high. The weather being very hot and dry, they would destroy acres a day. I am of the opinion that there were at least three if not four broods of the devils in the year, the last brood came out in the latter part of September, and it does look to me as if the little fellows had nearly all died off with cold, thirst and hunger, the sap being so completely dried up in the vegetation when they came out they could find nothing to feed on; in the fields one could see them by the millions crawling on the ground hunting something to feed on; one can see millions or legions of dead ones in the dry corn-stalks. I made a close search for live ones the other day; I only found two alive. I am satisfied with the same pains last Winter one could have found thousands of them alive. I give it as my opinion that if they died off everywhere else in Missouri as they have here, they will do but little damage next season.—W. L. S.

3—No effort has been made yet. Last Fall many farmers did not sow any wheat on account of the bugs. About your Second Annual Report, there may be some in the county, but I do not know of a single copy.—C. J. H.

[The other answers are to the same effect.]

4—The damage this year is more than I am able to estimate correctly; it is thousands of dollars.—W. L. S. The damage this year is great, but I cannot give a correct estimate.—J. W. D. To give an estimate of the damage done by chinch bugs would be impossible for me to do. I think about one-fourth the wheat crop was destroyed, and over four-fifths of the corn crop, and one-third of oats and young timothy. * * * My idea is, if we would plant no corn, or all early corn that would ripen before the second crop of bugs would be hatched, there would be no bugs to Winter, and that would run them out. C. J. H.

Holt County.

3—None. Your former reports have not circulated much beyond the officers of our agricultural society. B. K.—No. I have the first man to find yet that ever heard

of the Report you speak of. J. W. C.—Where they exist in stubble, it is found that Fall plowing exterminates many of them. This recently has also been found to be effectual in destroying grasshoppers, that is, where they are turned under pretty deep before being hatched. Your Reports are extensively read by farmers in Northwest Missouri. The only fault being that they are not generally distributed; but few copies ever find their way here only through our Representative, and they fall far short of the demand. Many of our newspapers, through downright ignorance of what they are writing about, speak lightly of the results of your department, as they do also of the agricultural department. I think that if your Reports, besides being published in book form, could be distributed in printed slips as fast as prepared, and published in the county papers, at least, a great amount of good might be effected. Nearly every farmer of any intelligence might be reached in that way. The State had better pay for the printing of such information in the newspapers than for the publication of the laws, as very few men read the latter, but depend solely for their interpretation upon the lawyers and others who read them. —W. K.

4—My estimate of their damage in this county for 1874, is as follows, to-wit.:

To 1,000,000 bushels corn, at 50 cents per bushel	$500,000
To 40,000 bushels small grain, at same	20,000
To 2,000 gardens, at $10 each	20,000
Total damages, actual	$540,000

This is a low estimate.—B. K. You cannot get two farmers to agree about what they were damaged. I believe my corn was damaged at least one-half, or thirty bushels to the acre; my wheat but little.—J. W. C.

Howard County.

3—None. Was not much distributed or known.—G. W. M.

4—The corn suffered more than wheat this year; $50,000 approximate damage—G. W. M.

Iron County.

3—No systematic efforts have been made to check them. Few, if any, copies of your Reports have been distributed here—W. C.

4—Damage may be divided as follows: Corn, $100,000 to $125,000, (⅔ of the crop); wheat, $30,000 to $45,000; oats, timothy, Hungarian and sorghum, (last destroyed), $20,000 to $30,000. My own experience is that by sowing no Fall wheat, except what can be sown early and well, and rye same, we might in a few years rid ourselves of this pest. I have noticed that in a spot manured lightly with stable muck, Fall wheat *never* suffers. If the ground is strong enough to give a good, healthy straw, carrying plenty of silica or glazing up with it, they *cannot* damage it much, and if stubble and trash was more generally burned, they would not breed in it, or under it, rather. The young broods get out here in the latter half of June, and early wheat is ready for the sickle by the 15th or 20th. Spring wheat seems to encourage and increase them more than anything else. I have not had the time or means to experiment, but think the best way, after the way suggested above, to prevent them, or even better perhaps with it, would be to sow thickly a strip of Spring wheat around the Fall wheat, and then when they had sucked it dry, which they would as soon as the Fall wheat was out, and before they began to move for other fodder, set it on fire after nightfall, if practicable, to prevent their flying from the flames. A strip of sorghum sown or planted in rows would entice and delay them, but would not burn unless straw or other combustible material was strewn in it. P. S.—I was hauling stock fodder for my stock the other day, and observed a great many chinches that were dormant, but quickened when exposed a minute or two to the warm sun, and it occurred to me that after this, whenever I had a cornfield infested with Chinch Bug I would cut and shock it all up, so that when it was hauled out in the Winter, while the bug was dormant and helpless, they would be ex-

posed, trodden in the manure and destroyed. Certain it is that where they swarm as thickly as they have done here for three or four years, we should not adopt or practice one plan of destroying them, but every plan. It seems peculiarly unfortunate that at this juncture, when the productive industry of the whole country is reduced to such straits by having borne the onus of the hot-bed system of protection to manufacturing enterprises, that we should be compelled to contend at such a disadvantage with such an enemy as this, and yet, "looking through nature up to nature's God," I cannot but regard it as a blessing in disguise, for it will *compel* our slow, conservative clod-hoppers to adopt better and more careful methods of cultivation.—W. C.

Jackson County.

3—None that I have heard of. I never heard of your Second Report before. —W. S. P. (The other answers are to the same effect).

4—At least $150,000.—W. S. P. The damage done this year was immense, especially in the western half of the county. Half my corn crop was destroyed.—J. W. G. Impossible to give an estimate. They have almost ruined the farming interest in this county and State.—J. A. M. Two-thirds of crops ruined.—W. J. G. I would guess about $500,000.—DR. J. L. G.

Jasper County.

3—There have been no efforts made to overcome the Chinch Bug, except ditching between wheat and corn. By this means they have been kept off of corn for a time. We plow a deep and narrow ditch; then drag a round log back and forth in it to pulverize the dirt and wallow them in the dust, and if the weather is hot they die by the hundred thousand in these ditches, at noon day, especially if these ditches run north and south; but as soon as a sprinkle of rain comes so as to settle the dust, they cross over. In the meantime, the old ones are flying where they please, depositing their eggs, which soon hatch out. So you see by ditching we only save a few rows of corn from being killed outright. I have no idea of the extent of your Second Report among the farmers of this county.—J. M. P. No efforts have been made to destroy them, except to plow ditches and dragging logs in them. I have never seen your Second Report, nor can I learn of any one that has. * * *—T. M'W. (The other answers are to the same effect).

4—I cannot give approximately the damage done in this county this year by this insect. Suffice it to say, the damage is immense. * * *—J. M. P. In 1874 corn was not over one-fourth of a crop (if that) on account of drouth and bugs.—J. U. T. Wheat being very early in 1874, was not injured much, but oats was, and corn, I might say, was destroyed by them and the dry season. * * *—T. M'W. As to the estimated damage the chinch bugs have done the past year, I am unable to say, but will say our corn was almost an entire failure, a great many not raising a bushel, and none making a full crop; but the drouth was severe, and all other crops were hurt by the bugs.—W. G. L. C.

Johnson County.

3—People have tried a great many remedies but have not succeeded in defeating the bug. Your reports have never been distributed in this county to my knowledge.—W. C. Few efforts have been made to overcome their injuries. Some have tried sowing hemp between the wheat and corn, but of no avail—as soon as they become winged they fly over it. * * * Some years ago I manured one acre of ground in the Fall, (there were two acres in the piece, half being manured,) and sowed it in wheat. The next Summer the bugs worked on the wheat very bad. The acre that had no manure they almost ruined; but the manured acre they did not hurt; it ripened right. The other was very badly straw-fallen, and was very much shriveled. I have heard of others doing the same thing, and having the same success. In some parts of the county they have stopped raising wheat entirely, thinking to starve them out in the early part

of the season, so they cannot increase before harvest, and by so doing, we will get rid of them in a few years.—J. L. M.

4—About 50 per cent.—C. J. C. Five hundred thousand dollars won't cover the damage in Johnson county last Summer. The greatest damage was done by what is termed the second crop, depleting the corn before it matures.—J. M. M. I don't think that the damage done in this county this year would fall short of half a million of dollars, from the fact that half the wheat and almost the entire crop of corn was destroyed or badly injured. * * *—W. C. There is not a farmer that will make both ends meet in all this county. Many will be bankrupt, *and all this by one little insect called the Chinch Bug.*—DR. D. Thousands of acres of corn were killed as dead as if burned—not a stalk left. They took three-fourths of the wheat crop, and about the same of the oats In the southern part they took all the wheat and oats, and they took also nine-tenths of the corn. There is a diversity of opinion as to the amount of damage done by them, varying from one and a half to two millions of dollars for all crops.—J. L. M.

Laclede County.

3—No systematic efforts have been made to overcome their injuries. They usually make their first appearance in the wheatfields, but in every instance where the wheat was sown sufficiently early to allow it to mature early, they have not done any serious damage to it, but late sown wheat has pretty generally been destroyed by them. * * * The 2d brood made their appearance promiscuously over the fields, and more especially in meadows that were cut early enough to admit the young grass to start up, when they soon kill it outright, both root and branch. * * * —L. R. R.

4—It would be utterly impossible for me to give approximately anything like a correct estimate of the damage done in the county by the chinch bugs either in the present or any previous year. It is ascertained that they will not depredate upon hemp, flax, castor beans, navy or other kinds of beans.—L. R. R.

Lafayette County.

3—No effort has been made to check it. I know of but one copy of your Report—J. B. No systematic efforts have been made at their extermination. I do not think your Report has been circulated or is much known.—J. E. G.

4—Have no idea of the damage done in this county.—J. B. It is conceded by every one with whom I have conversed on the subject, that the drouth cut off at least one-half from an average crop, and the bug certainly injured the remainder fully one-half. * * * Wheat was of very fine quality, and a good yield, being only slightly injured by the bug; the very late sowing worse than early sowing, in this part of the county. The damage to this county by the bug will not fall short of half a million dollars.—J. J. F. Putting drouth and chinch bugs together, they came near causing an utter failure, there being only about one-fifth of a crop of the grains, and that fifth of inferior quality. —J. E. G.

Lawrence County.

4—Cannot give the exact amount of damage done; corn is about one-half a crop. My opinion and that of many other farmers is that $100,000 will not cover the damage done by the bugs.—W. L. G. (Other correspondents put the loss of sorghum and oats at fifty per cent).

Lewis County.

3—No systematic efforts have been made. I have never seen your Report.

4—I should think that one-tenth would be a fair estimate, corn suffering the greatest; yet we raised a fine crop, superior to any we have had for several years.—W. B. D.

Linn County.

3—There have been no systematic efforts made to overcome the injuries of the bug that I have any knowledge of. As to your Second Report, I have never seen it, and do not think it is known among the farmers of our county.—A. M.

4—I think the damage by the bugs, irrespective of drouth, equal one-half of the whole crop. The wheat crop was not damaged by the drouth, and oats but very slightly, yet I think both damaged by the chinch bugs to the amount of one-third.—A. M.

Macon County.

3—No. Do not know anything about the Report referred to.—W. B. M. About one-fourth—all grains considered—of the crops lost.—W. B. M.

Madison County.

3—We have found out no means to exterminate them. We, however, have burnt stubble and in so doing have destroyed many of them.—J. M. A. It would be safe to say that our crops were cut short fully one-fourth this season by the bugs, except early wheat, which matured before the insect did much damage.—J. M. A.

Maries County.

3—There have been various plans adopted to subdue the insect: one way was to ditch and drag a log in it; another was to scald them; another was to scatter straw under and around the corn and set fire to the straw. This latter plan seemed to prove a success, but only for awhile—a heavy gale from the north blowing innumerable bugs over the cornfield. * * * I have heard nothing of your Second Report.—D. L. D.

4—I am not able to answer your fourth question definitely. Corn yielded about eighty per cent. less than the average, chiefly on account of chinch bugs and drouth; oats about fifty per cent. less; wheat was about twenty-five per cent. better.—D. L. D.

Marion County.

3—Two years ago I had wheat and corn in the same field, and when the wheat was harvested the bugs went into the corn. I let them have about a week to get a start in the corn, then I took a breaking plow and turned about eight rows of corn, bugs and all under, as deep as I could, and then put a heavy roller on it and rolled it thoroughly, and that was the last of those bugs, I think, as the corn was but little injured afterward. I have no idea to what extent your Second Report has been distributed in the county, but in this neighborhood there is nothing known about it.—J. K. M.

4—By consulting a number of the best farmers, we conclude the crops have been injured about one-fourth this year by the bugs.—J. K. M. I should estimate the damage done to the crops in this county alone this year to be at least $50,000.—W. R. A.

McDonald County.

3—There has been nothing of note done to prevent or destroy them. As for your Report I do not know of a single copy in the whole county.—W. D. P.

Mercer County.

3—No systematic effort has been made to overcome the bug or its injuries. Little or nothing is known of your Report of 1869, as but very few copies of the Agricultural Reports reach here.—J. H. B.

4—It would be a very difficult task to approximate the damage done by this *great pest.* In this county it may be put at $100,000 to $500,000.—J. H. B.

Mississippi County.

3—No. I do not know of any person that has received a copy.—S. S. S.

4—Impossible to make a truthful estimate.—S. S. S.

Monroe County.

4—It has damaged oats and corn one-half, wheat three-eights. Cannot give an estimate in dollars and cents.—J. P. M.

Montgomery County.

3—Fire is being used against them this Winter very much, burning old litter of all kinds. In Summer shallow ditches are made with the plow and logs and other weights dragged along those ditches to keep them from going in standing crops.—D. T. M. There have been no systematic efforts made to overcome its injuries. I do not think your Second Report has been distributed or known among the farmers of Montgomery county to any extent.—E. R. B.

4—From the best information I can get and from actual observation, I would say that the corn crop of the county was injured one-fourth. Wheat was less injured generally than for several years. I could not well approximate the damage in dollars and cents.—E. R. B.

New Madrid County.

3—No systematic efforts have ever been made to overcome its injuries. I do not think your Second Report is extensively circulated among farmers in the county.—J. S. B.

4—It would be impossible to give, even approximately, the damage done to this year's crop. It was comparatively slight.—J. S. B.

Newton County.

3—I think none at all. I have not even seen your Report before, and do not think there are many, if any at all, in the hands of farmers in this county.—J. T. No systematic efforts have ever been made to overcome its injuries. If any of your reports have ever reached this county, I have been unable to find one.—W. H. W.

4—It is very difficult to tell anything about the amount of damage, on account of the great drouth, but it was many thousand dollars.—J. T. They damaged the wheat about one-fourth, and killed nearly all the corn.—W. H. W.

Nodaway County.

3—While I was a member of the Twenty-sixth General Assembly, I secured about 40 copies of your Second Report from various sources and distributed them amongst our leading farmers and fruit-growers. These, I think, are about all that have been received in our county, although it has been eagerly sought for and fully appreciated by our people.—W. B. M. H. None. I think about one farmer in fifty has your report, and perhaps one-fourth have studied the insect's history.—W. P. Odessa Spring wheat is generally considered here as best standing their injuries, but has not been sufficiently tested to speak positively in regard to its merits.—T. D. W.

4—This year it damaged oats fully 3 bushels per acre, and Spring wheat 2 bushels; Fall wheat, rye and barley about 1 bushel per acre. The first crop of tame hay it did not injure, but the aftermath was cut short fully one-fourth ton per acre, and corn about 6 bushels per acre.—W. B. M. H. One hundred thousand dollars.—W. P.

Oregon County.

3—No. I have no definite idea, but believe there were very few copies distributed. —J. R. W.

4—About ten per cent.—J. R. W.

Osage County.

3—No systematic efforts to overcome their injuries have been made to my knowledge. Some have tried to keep them from spreading all over their farms by plowing and ditching, some by sprinkling a few rows of their corn in advance of them with a mixture of coal oil and water. It kept them from crossing for a few days, but did not prevent them from flying over and destroying the balance of the crop. Your Second Report was distributed among a limited number of farmers.—L. P.

4—The estimated damage done this year in this county by the Chinch Bug may be put down thus: wheat, one-fourth of the crop; corn, three-fourths of the crop; hay,

one-half; oats, one-third—which would amount to several hundred thousands of bushels of grain, and several hundreds of tons of hay without the loss of meadows, for they have destroyed mine root and branch, besides a good many others.—L. P.

Ozark County.

3—None.—T. J. G.

4—About one-half the crops destroyed.—T. J. G.

Perry County.

1—We have been troubled with them for eleven or twelve years. Some years they do but little damage, and other years, generally dry seasons, they nearly ruin our crops, especially late corn. About five years ago the bugs were very bad and the next year we expected to have our crops entirely destroyed by them, but they had nearly disappeared. Last Summer they were very bad, it being a dry season, and they damaged corn very much; wheat being very early escaped their injuries.—R. M. B.

Pettis County.

3—None. I have never seen your Report; have tried to get it but failed.—L. H. W. No systematic efforts have been made to overcome its injuries. In regard to your Second Report, I have to say that probably not twenty copies have been distributed in this county. I never saw one, nor have I heard it mentioned by a single farmer of the county. Permit me to suggest that all your Entomological reports would be of vast importance to the farmers if placed in their hands, either with or without the Agricultural Reports. I have received two of them, and hoped to be able to secure them all as fast as published, but have been unable to do so—O. A. C.

4—I think $5 per acre as the loss sustained by the corn crop alone would be a low estimate.—L. H. W. The damage done by the Chinch Bug alone is alarming; it cannot be less than $300,000, including damage done to all kinds of crops.—E. C. The damage done by them last year was great, but it is impossible to make anything like a correct estimate, as the drouth did greater damage, and both were upon us at the same time. In the south part of the county the oats and corn crops were entirely destroyed, while in the northern part of the county, where the soil is deeper, not more than one-fourth of a crop was raised.—O. A. C.

Platte County.

4—Not less than $100,000.—J. A.

Polk County.

2—But little damage was done to the wheat crop, but the oats, corn and Hungarian grass was badly damaged all over the county, and a great many fields entirely destroyed. * * * The farmers of this county are beginning to cut off their corn and pull the stalks whenever they can feed them to their stock, thinking in that way to destroy their eggs, which they think are deposited in the husks and blades, and in fact any kind of leaves or trash about the fences seem to be where they deposit their eggs. —J. C. [This is of course a fallacy.]

3—Plowing and dragging logs are the only means reported; and but few copies of the Report have been seen.

4—$500,000. Do not know as these figures are near large enough; would think $800,000 or $900,000 would be nearer the truth.—* * I think I am safe in saying that the entire grain crop of this county was damaged one-half by the bugs.—T. W. S. Wheat crop was not damaged much; corn crop almost a total failure.—M. D. M.

Pulaski County.

3—Nothing has yet been done to any extent to overcome its injuries. Your Second Report has been read by the reading farmers of my county; but a few copies have been sent us.—C. C. There have been no systematic efforts made to overcome its inju-

ries. I have no idea to what extent your Second Report was distributed or known among the farmers in this county, but think there were but few distributed.—O. J. R.

4—Caused a loss to our county in corn, as near as I am able to calculate, of 132,750 bushels at fifty cents per bushel, $66,375. There is no doubt but that the hot winds during the second week in August and the drouth during the Summer had a serious effect upon the corn crop, but nothing to be compared to the injury of the Chinch.—C. C.

Putnam County.

3—No effort has ever been made to stay their ravages. The report of which you speak is probably oftener to be found among the books of professional men at the county seat than among the farmers.—A. D. T.

4—The damage by Chinch Bug this year was not, comparatively, great. It was confined to late sown wheat and late planted corn.—A. D. T.

Ralls County.

3—Nothing is known here of your Report. There are not more than three or four copies of that Agricultural Report in the county of Ralls.—A. E. T.

4—Injured crops 25 per cent. Saw a man who lives in Sny bottom; says prairie grass cut last year is so infested with chinch bugs the stock will not eat it, and some mules that eat it have died. I have seen in the last ten days any quantity of them sticking on the prairie fences and alive. Following your advice, I burnt some weeks ago 200 acres of rubbish on my prairie place, twenty-five miles from here, and hope I scorched some of the rascals. They are worse on prairie than timber land.—A. E. T.

Randolph County.

3—Do not know of any systematic efforts to overcome its injuries. Have never heard your Report mentioned in connection with it; do not know that any of the farmers of our county have seen the Report.—W. Q.

4—Would estimate its damage, the present year, in this county, at $20,000.—W. Q.

Ray County.

4—Corn, 50 per cent.; wheat, 25 per cent. * * ——. They did not injure the crops very much in this part of the county, but in the eastern and northern parts the amount of damage is at least from $25,000 to to $50,000. Not one-fourth of a crop of corn was raised there, and people will have to suffer.—J. M. B.

Ripley County.

3—No efforts made to overcome its injuries in any shape or form. Your Second Report went into the hands of about one farmer out of every fifty. You may justly suspect we know but little about it.—R. H.

4—The damage in my county I could not approximately say less than $40,000, all crops considered.—B. H.

St. Charles County.

3—No systematic effort made. Some tried hot water, others coal oil, and still others tried to stop them by ditching across the field. Your Report of 1869 is distributed in the county to about the number of thirty, as near as I know.—C. W.

4—By information gathered, I can safely estimate the damage done by the bugs in this county last year at $25,000, which is very low.—C. W.

St. Clair County.

3—Various plans tried, but without much effect. The distribution of your Report has been very limited in this county.—S. H. L. Although seemingly every effort has been made to subdue them, they have come out victorious—complete masters of the situation. Between them and the dry weather we have scarcely anything left to carry us through Winter. Many have despaired and left in disgust, others will remain and

renew the combat. The Agricultural Reports spoken of were sent to the circuit clerk for distribution, and it is my opinion that they have generally been injudiciously distributed, finding their way to some favorite to fill up empty spaces in a book case, rather than to the farmer for whom they were intended. But your suggestions contained therein are becoming generally known among the farmers, and will be pretty thoroughly tested the coming season. The case has become desperate—something must be done or all is lost.—C. A. S.

4—The damage from Chinch Bug and drouth, in my township, was $15,000. There are twenty-four townships in the county; all did not suffer as much as this T. (31,) R. (28) west, but the damage may be put down at one-half on an aggregate.—S. H. L. An estimate of the damages done in the county of St. Clair, the past season, by these insects alone would be hard to even approximate. Owing to a combination of causes, wheat, oats and corn were almost an entire failure; three-fourths of which, however, might be attributed solely to the Chich Bug crusade, and the damage resulting therefrom could not fall short of a half million of dollars.—C. A. S.

St. Francois County.

3—Few efforts have ever been made to overcome its injuries. Some have tried to check them, when entering a corn-field from adjoining stubble grounds, by turning them under with a large plow; others, by letting them collect on a few of the first rows, and burning them with torches. Neither of these plans appear to be very effectual. A great many are destroyed to be sure, but enough generally escape to seriously injure the corn crops. The Report mentioned has had a very limited circulation. I don't know of any one who has ever received it.—E. H. P.

[The other correspondents make similar reports].

4—I don't know that I can give you even an approximate estimate of the damage done in this county this year by this insect. I believe there would have been double the corn, a fourth more wheat and oats, and, perhaps, a fourth more grass raised this season had it not been for the Chinch Bug.—E. H. P. Wheat only slightly damaged; corn very materially damaged.—A. J. L.

Ste. Genevieve County.

3—No great effort has ever been made to overcome its injuries as yet, with the exception of pouring coal oil on them, which destroyed both bugs and crop. As to your Second Report, there is nothing known of it here.—J. R. P.

4—This year the corn crop was injured fully one-half; wheat was affected in some places. Other crops were lightly dealt with.—J. R. P.

Saline County.

3—There has been nothing of any consequence done to destroy them. Your Report is received, for which I return my sincere thanks. I am sorry to say that there are comparatively very few of them in this county, and if the knowledge contained in them was universally known in this county, I am satisfied that it would enable us to meet our enemies, the bugs, determined to conquer.—J. P. M'M.

4—I cannot give the required estimate in regard to the damage incurred to crops. Suffice it to say that the chinch bugs and dry weather completely destroyed the oat crop and damaged the corn crop to the extent that there was not more than one-third of the amount raised as formerly.—J. P. M'M.

Scotland County.

3—Not many copies of your Second Report have reached this county.—A. N.

4—I don't hardly know what to estimate the damage done in this county the past season, but I think $100,000 will not fall short of it.—A. N.

Scott County.

4—Their damage in this county approximates $50,000.—H. P. L.

Shelby County.

The crops suffering most are wheat and corn. * * * I have noticed when the wheat covers well the ground (which it may be made to do by thorough manuring) in the Spring, so as to almost exclude the rays of the sun, the chinch bugs do not gather to raise their young there, but seek more open grain. If oats are sowed early and thick, and make a strong, vigorous growth, I have never known the Chinch Bug to hurt them, but if they are thin on the ground, admitting the rays of the sun freely, then oats are a fine crop to raise chinch bugs in. * * *.—J. B. R.

3—No systematic efforts made. I have not been able to hear of the first copy of your Second Report. I suppose they were sent to the county seat and distributed among those living near there.—J. B. R.

4—Cannot give you, with any great certainty, the damage our crops have sustained from chinch bugs the past year, but would suppose the damage to amount to about one-fifth of the value of the crops thus affected.—J. B. R.

Sullivan County.

3—Never saw your Second Report, or saw any person who did see it. The best thing, in my opinion, and it is simply my opinion, is to manure the points and other poor places and burn up the trash around the field and in the fence corners early in the Spring. They never injure a crop on rich land and growing thrifty, as they do on poor land. You would certainly deserve the gratitude of the people of Missouri if you could do anything to relieve them of this pest, or by studying its habits teach us to exterminate them. * * * —S. B.

4—Impossible to estimate.—S. B.

Taney County.

3—None have been made. But very few copies of your reports have been distributed —20 copies perhaps.—J. J. B. There have been no efforts made to overcome its injuries. Your Second Report has been distributed over the county by the State, but not to an extent that one-tenth of the farmers might read it.—W. R. H.

4—I cannot make anything like a close estimate of the value of the produce destroyed, though I should judge that it would amount to $20,000 to $30,000.—J. J. B. * * * From careful calculations, I conclude that Taney county lost over $45,000 by this insect in 1874. These calculations are based upon the census report of 1870 and the assessor's report of 1874. These figures are enormous, and by some may be considered extravagant, but if any one will visit our county and see the state of affairs—starvation staring everybody in the face, stock dying, etc., etc., the effects of dry weather and chinch bugs—they may be convinced.—W. R. H.

Texas County.

3—Some have tried scalding on a few favorite plants; it kills the bug and does not hurt the plant. No other systematic efforts have been made.—R. S. S.

4—I cannot give an estimate of the damage done; say one-half oats, corn and sorghum.—R. S. S.

Vernon County.

3—None whatever. Think there are not more than two or three of the Reports mentioned in the county.—J. A. P.

4—From all the information I have been able to gather in regard to the damage done by this insect, I do not believe it would fall far short of half a million dollars, all crops considered; and if we take into consideration the loss to farmers on account of stock, another half million dollars might be added, as farmers were compelled to sell their stock at a great sacrifice for the want of feed to make them ready for market, or put them through the winter, all of which is chargeable to the Chinch Bug, for

although we had a very dry season, yet we would have harvested at least ninety per cent of a corn crop, and there would have been an average yield of wheat and oats.—M. L. M. It is impossible, at this time to closely approximate the damage in dollars and cents sustained by them this year, but may safely place it at one-half of the entire wheat, oats and corn crop of the county, for notwithstanding the drouth which prevailed, we certainly would have harvested a full crop of wheat and oats, and one-half of corn.—J. A. P.

Warren County.

4—Can't make any estimate in figures; would say about 50 per cent. on all uplands; on creek and river bottom lands the damage has been small.—D. P. D.

Washington County.

3—No efforts made to overcome them; very few of your reports in this county.—W. R.

4—As to the damage done by them it is hard to determine; we raised about one-fourth of a crop of corn and oats, and it is the opinion of our best farmers that the bugs hurt it much more than the drouth. Wheat escaped pretty much, as it was very forward. * * * —W. R.

Wright County.

3—There have not been any systematic effort made as yet. We know nothing about your Report. * * *—E. B. G.

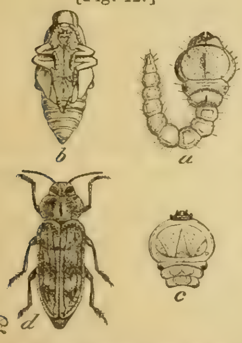
4—Corn is damaged, I think, probably, one-third; oats the same; wheat so little I could not estimate it. I have no way of getting at the amount in dollars and cents, but it is immense. My opinion is that Fall plowing, thorough cultivation of the land, and as early planting and seeding as possible, will in a great measure overcome their ravages; such has been my experience.—E. B. G.

THE FLAT-HEADED APPLE-TREE BORER—*Chrysobothris femorata** (Fabr.)

(Ord. COLEOPTERA; Fam. BUPRESTIDÆ.)

This insect, owing to the enfeebled condition of many fruit and shade trees—a condition superinduced in part by excessive drouth, in part by defoliation, in the country ravaged by locusts—has been exceedingly injurious all over the western portion of the country. Specimens and complaints have reached me not only from many parts of Missouri, but from Iowa, Kansas, Arkansas, Texas and Nebraska; while the injurious work of this borer was so apparent wherever I traveled that I deem it advisable to publish a more extended account than was given in the Report for 1868.

[Fig. 12.]



CHRYSOBOTHRIS FEMORATA: *a*, larva, dorsal view; *b*, pupa; *c*, swollen thoracic joints of larva from beneath; *d*, beetle.

Considering the fatality of its work and the number of valuable fruit and shade trees which it attacks, few insects are more to be dreaded than this same Flat-headed Apple-tree Borer.

* Crotch in his *List* makes *alabamæ* Gory, 4-*impressa* Gory, *Lesueuri* Gory, *fastidiosa* Gory, *soror* Lec., *misella* Lec., *obscura* Lec. and *semisculpta* Lec., varieties or synonymes of *femorata*. My own experience so far as it goes in breeding this insect from different trees bears out Mr. Crotch's opinion.

Our oak trees die from year to year. Inquire the cause: The answer is: "O, they cannot stand the influences of civilization!" Search for it yourself and you will find that Chrysobothris has had more or less to do with their death. The townsman prides himself on the thrifty growth of his soft maples or sycamore trees that are to give him shade from the midsummer sun, adorn his lot or line the front of his city residence. After a thrifty growth of two, three or more years, one of the trees suddenly dies, and others soon follow. The cause is discussed: Drouth, packed soil, poor nourishment and a dozen seemingly plausible reasons are conjured up, and ashes, or some other mineral or vegetable substances are placed around the butt in the vain effort to save the remaining trees. Pull off the bark, however, and the real cause is readily discerned, for the surface of the hard wood is literally covered with broad, shallow channels packed with sawdust like casting—channels which Chrysobothris, unseen and unheard, has been making, perchance, since the tree was first set out. Mountain Ash, Linden, Box-elder, Beech, Plum, Pear, Cherry and Peach alike succumb to its attacks,* while the Apple is so subject to its injuries that no man who does not understand this enemy and is not willing to give some little time to mastering it, can hope to succeed in growing apple trees in Missouri; and in reality the time and money spent in planting young apple orchards, especially in the western part of the State, is generally wasted for want of the necessary precautions against this insect.

ITS NATURAL HISTORY.

The natural history of this borer is thus briefly told: The beetle, known as the Thick-legged Buprestian, is very variable in size (my figure at *d* representing a large one), and has been described under a number of different names. It is greenish-black or bronze-colored, with metallic reflections and the underside more coppery or brassy. The more characteristic features are two irregular, impressed, transverse marks across each wing-cover, dividing them into about three equal lengths. This beetle, like all the species of the family (*Buprestidæ*) to which it belongs, is diurnal in habit, and may frequently be found basking in the sun on the trunks of those trees which it more particularly frequents. It begins to appear during the latter part of May and is found all through the Summer months. The eggs, which

*I have reared the beetle from Oak, Apple, Mountain Ash, Box-elder, Peach and Pear, and found the larvæ, judged to be the same after critical comparison, in the other trees mentioned.

are pale yellow, and irregularly ribbed or corrugated,* are glued by the female by preference under the loose scales or within the cracks and crevices of the bark, several of them being not unfrequently found together. Yet they must also be laid at times on perfectly smooth bark, as I have found the newly hatched larva in such bark, and under circumstances that would indicate that the beetle sometimes uses her jaws to puncture the tender bark so as to allow the insertion of the egg. The young larvæ hatching from them gnaw through the bark and feed upon the fiber, boring broad and flattened channels, and very soon girdling the smaller trees. When its jaws get stronger it usually bores into the more solid wood, working for awhile upward, and when about to transform it invariably cuts a passage back again to the outside, leaving but a thin covering of bark over the hole. It then retreats, and after packing the excrement around it so as to form a smooth cavity, changes to the pupa state (Fig. 12, *b*). The pupa at first white, by degrees exhibits the colors of the future beetle, and in the course of about three weeks the latter gnaws its way through the thin bark door which, as larva, it had left closing its passage-way. It is a singular instinct that thus teaches the larva, which has powerful jaws, to prepare for the exit of the beetle, which has much more feeble ones; and this instinct is most strikingly illustrated when the infested tree is surrounded with some covering like wire gauze, which is proof against even the jaws of the larva. In such an event, even though the wire touch not the bark, the larva will work its way through the latter, and test in every conceivable way the resistance of the wire, and frequently succumb in the effort to penetrate it. Yet normally this same larva would take every precaution not to penetrate the bark.

Whether this borer remains in the tree nigh upon one or two years after hatching, no one has definitely determined. The general impression is that it acquires its full development in a single year. Be this as it may, the larvæ are found of different sizes during the late Summer, and young ones may be noticed even in Winter. In May they are mostly found full grown or in the pupa state. The figures which accompany this article will sufficiently illustrate the appearance of the insect in all its stages, no drawing of the pupa having ever been made before.

NATURAL ENEMIES.

Hidden as this borer naturally is within the retreat of its own

* Eggs which I have found on apple trees, and taken for those of this insect, and which accord in appearance with those taken from the abdomen of the female beetle, are about 0.02 inch long, ovoidal, with one end flattened; the shell very thin, and irregularly ribbed.

making, it is nevertheless hunted and destroyed by wood-peckers, and is not without its insect parasites. Already, in 1856, Dr. Fitch, in his first report as State Entomologist of New York, mentioned having received from that veteran nuseryman, Mr. P. Barry, specimens of the larvæ which had been entirely devoured, so that nothing but the shrivelled skin remained, by a number of small dull whitish grubs, about one-tenth of an inch long, belonging, in all probability, to the *Chalcididæ*, an extensive family of small, parasitic, wasp-like insects; and this Fall I have received what are evidently the same Chalcid larvæ from Mr. R. H. Titts, of Lawrence, Kansas, who gives the following interesting account of their work:

The first time we observed these parasites here this season, one of my neighbors remarked that he thought that there was a mistake about a beetle laying the egg that produced the borer. In hunting borers on my own place shortly after I found some of them were sickly or stupid and of a peculiar yellowish color, different from natural. One of these that I had not injured I left in the cavity where found, and closed up the bark, fastening it with wax. After about ten days, on opening it again, I found the parasites at work and the borer dead and partly eaten up; after which I found them frequently in different stages of growth, till the borer was all consumed and the parasites were of the size of those sent you. Those were taken from a cavity with nothing but a part of the skin of the borer left. I did not find them again until about September 1st, after which time I think but few if any borers escaped them. I stopped hunting borers after September 15th, satisfied that the parasites were doing a better job than I could. Others in this section are doing the same. I think that although the borers were much more plenty this season than last there will be less beetles perfected to issue than last year, on account of the parasites. In digging borers I found that if the mouth of the hole in which they had entered the tree was opened the ants would go in and destroy and carry the borer away in every instance, even clearing out the sawdust to get at them.

The following letter, received from Mr. C. R. Hoag, of Sedalia, the fore part of December, was accompanied by the same parasite:

Inclosed I send you the larva of an insect unknown to me; it is the second lot that I have found in a precisely similar situation. I send them in the dust or borings in which they were found; they were found in an apple tree in the bed of the Flat-headed Borer, after he had penetrated the solid wood of the tree. The borer had evidently been destroyed by the small larva, as there was in this latter instance no part of the borer to be found, and in the former but small portions of the skin partly surrounded by the small maggots. I am in hopes that they may prove to be the larva of an insect that is a common enemy to the most destructive pest of the orchard. The ravages of this borer during the past season, in this part of the country, have been unprecedented; it has been a great deal more numerous than the Saperda or Round-headed Borer, that works near the ground. Heretofore (in my experience) they have seldom attacked a healthy and thrifty tree, but have confined their ravages to trees that have received a severe check in transplanting and in bad usage generally. During the past season they have attacked the healthy as well as the unhealthy trees.

I have not succeeded in rearing the perfect fly from these small maggot-like larvæ, but there can be no doubt that it will prove as Dr. Fitch surmised, to belong to the *Chalcididæ*, an extensive family of small 4-winged flies of black or metallic colors, ever on the alert for prey, and sometimes attacking the vegetable feeders at first hand, but more often acting as secondary parasites. In the present instance the minute mother fly must manage to insinuate herself in

the burrow of Chrysobothris, and, having reached the borer, pierce the skin and consign her eggs in its body.*

I have bred two other much larger parasites from this borer, both of which belong to the large family of Ichneumons, and reach the borer by means of a long sting or ovipositor. The first of these, which may be called the Cherished Bracon is an undescribed four-winged fly, with the head, thorax, antennæ and legs polished black, the abdomen coral-red, and the wings deep smoky-brown. It expands about 0.65 inch, the body has a length of 0.35 inch and the ovipositor of 0.40 inch. The sting or ovipositor consists of a pale yellow, central terebra, and two stouter black sheaths. The larva, after destroying its victim, spins a yellowish-brown cocoon, flat on two sides, and not unlike a miniture coffin, and the perfect fly issues in Spring through the burrow which the Chrysobothris would have used had it been allowed to live. This parasite is quite common, and though I have reared it on three different occasions, it was in each instance parasitic on Chrysobothris. Specimens sent to the well known Hymenopterist, E. T. Cresson, two years since, were pronounced new, and as no American species of the genus have since been described, I append a description:

[Fig. 13.]

BRACON CHARUS:—Parasite of Chrysobothris.

BRACON CHARUS, N. sp. (Fig. 13)—♀ Length of body 0.35 inch; of ovipositor 0.40 inch; expanse of wing, 0.65 inch. Colors black and deep rufous. Head, thorax, legs and antennæ polished black, the legs and sides of head and thorax with a fine grayish pubescence; trophi also black. Abdomen uniformly deep rufous. Terebra of ovipositor pale yellow, the sheaths black and very faintly pubescent. Wings deep fuliginous with a faint zig-zag, clear line across the middle from the stigma.

Described from 7 ♀'s, all breed from *Chrysobothris femorata*.

The other Ichneumon-fly is somewhat larger, and may be called the Useful Labena. It is the *Cryptus grallator* of Say, subsequently described as *Mesochorus fuscipennis* by Brullé, and belongs to the modern genus *Labena* Cresson. Its body is half an inch long, but the ovipositor has only a length of 0.30 inch. The general color of the body is honey-yellow inclining to brownish, and the wings, which expand nearly an inch, are clouded each with two broad, smoky-brown

* As this Report is going through the press, my friend, A. S. Fuller, of Ridgewood, N. J., sends me a number of these Chalcid maggots that have preyed on the Chrysobothris larva, and which he received from Prairie City, Mo.

patches, the light parts being hyaline. The antennæ are reddish-brown, yellow beyond the middle and dark brown toward tips; the ovipositor has the terebra dark and the sheaths yellow with dark brown extremities. Full descriptions of the species under the name of *Labena grallator* have been published by Mr. Cresson* and by Mr. Walsh,† who bred it from hickory wood infested with the larva of *Cerasphorus cinctus*, a longicorn beetle. This fact shows that the Useful Labena is not confined in its attacks to the larva of Chrysobothris, as the other species seems to be. I bred this fly from a Chrysobothris larva infesting an apple tree. It was handed to me by Mr. W. W. Tipton, of Burlington, Kansas, just as it was spinning a delicate transparent cocoon, and Mr. T. felt sure that he had made a grand discovery, and that entomologists had all been wrong in not stating that the flat-headed apple tree borer makes a cocoon. Persons unfamiliar with parasitism in the insect world are apt to jump to such hasty conclusions; and it is only necessary in this connection to say that the Chrysobothris *never does make a silken* cocoon, and that whenever such is found in its burrow, its contents should not be crushed, but allowed to mature and escape.

Where the Chrysobothris breeds in felled oak logs or in stumps, it is often destroyed by ants, and they doubtless frequently reach it even in growing trees, especially when the entrance is exposed, as just described by Mr. Titts.

REMEDIES.

In treating of the means to be employed against this Flat-headed borer, one important fact should be borne in mind. The natural breeding place of the insect is undoubtedly in the old decaying oaks of our woods, and I have known it to swarm in old post-oak stumps from which the tops had been felled for a number of years. In fact it prefers partially dead or injured trees to those which are thrifty and vigorous, and partly for this reason, and partly because rough, cracked bark forms a better nidus for the female to lay her eggs, the species is most abundantly found on the southwest side of young apple trees where they are most apt to get injured by sunscald. Sickliness in the tree, injury from the whiffletree or other cause, therefore, predispose to its attacks. It is for this reason that transplanted trees, checked as they are in their growth, usually fare badly. But there is yet one other predisposing cause which few people suspect, and that is reck-

* Proc. Phil. Ent. Soc. III, pp. 400–1.

† Trans. Ac. Sc. of St. Louis, III, pp. 162-3.

less and careless pruning, especially of the larger branches. Many a fine orchard tree, and many more city shade trees receive their death shock from the reckless sawing off of limbs without effort being made to heal the wounds by coating with grafting wax, clay or other protecting substances. Around such an unprotected sawed limb, as around the frustum of a felled tree, the rain and other atmospheric influences soon begin their work of causing decay between the bark and the solid wood ; and this is but the forerunner of greater injury by insects which are attracted to the spot, and which, though hidden meanwhile from view, soon carry the destruction from the injured to the non-injured parts. Among the insects thus attracted, Chrysobothris plays no mean part, where, had the wounded limb been properly protected, its presence would never have been known. It thus becomes of the first importance, in treating this insect, to keep the young trees vigorous and healthy, and the bark as smooth and as free from injury as possible. Thus in planting a young orchard in this part of the country, where the sun (whether indirectly or directly is for the vegetable pathologist to determine) is apt to injure the bark on the southwest side, it will prove labor well spent to protect them on that side by old paling or lath. Young trees are far more liable to be attacked than old ones, and consequently require greater care.

A healthy and vigorous tree is not chosen by the female, in depositing, if unhealthy or injured trees are at hand; and when eggs are deposited in trees of the former character, the young borers more often perish—are drowned out. Yet it must not be supposed, on this account, that the insect cannot live in a healthy tree, for he who should act on this principle and take no other precautions against its attacks than good cultivation, would too often discover his mistake. That the insect is seldom if ever found in healthy trees is a necessary truism which often deludes into belief that it cannot attack such. As soon as the borer is at work the tree ceases to be healthy; and while careful culture and protection from other injury are excellent preventives against its attacks, they are not infallible.

As a preventive against the insect's attacks there is nothing better than coating the trunks and larger branches with soap at least twice a year, once toward the end of May and again in July or August. The soap is not only obnoxious to the beetle, but it tends to keep the bark clean and smooth, so as to offer no attraction to the female, and is, withal, beneficial to the tree.

Mr. Henry Shaw, who has had a good deal of trouble from the work of this borer on the young trees in Tower Grove Park, St. Louis,

has finally painted them with a mixture of soap, lime and a small proportion of Paris Green. The Green might, I think, be dispensed with, but the lime gives consistency as well as persistency to the soap, and in many of the trees thus treated the larvæ have actually worked their way out only to fall to the ground and perish. A small proportion of glue dissolved in the mixture would add still more to its persistency, and, being gradually dissolved by the rains, not injure the tree.

Other substances have been applied to trees as preventives of the attacks of this insect, and right here the question is naturaly asked, "does it hurt trees to grease them?" The question has been discussed for many years by horticultural bodies, and the individual experience is always conflicting. Indeed, it only admits of a conditional answer, as so much depends on the quality of the grease and the time of year in which it is applied. All greasy substances of such consistence that they will effectually preclude the air for any length of time must necessarily be injurious, whereas, if they soon evaporate or crack open they may be applied so as to produce no injurious effects. Kerosene and axle grease have been used by several prominent Kansas fruit-growers, without injury to the tree, and with satisfactory results in keeping off both borers and rabbits. Coal tar has also been used for the same purposes, and with satisfaction, by many, and is now being extensively tried in the college orchards at Manhattan, and by H. E. Van Deman of Geneva, and others; while pitch tar applied direct to the tree is generally injurious.

From what has already been said we see the importance of keeping the bark smooth, whether by the use of soap or by scraping. The former mode of keeping the bark smooth is altogether preferable, not only because it is more obnoxious to the beetle, but because it is less hurtful to the tree. For it is a fact, exemplified in the experience of Mr. Wm. R. Randall, of Washtenaw county, Michigan, as communicated to the *New York Tribune*, that in scraping trees or in using a knife to cut off the loose bark, the fresh bark is often abraded and bruised so as to form just the nidus needed by the beetle. And Mr. Randall found that the very parts which he had left exposed in this manner by Summer scraping were afterwards well supplied with borers. Scraping, therefore—if it has to be done—should be done early in Spring, before the beetle appears, so that any unavoidable bruising may have time to heal before Chrysobothris is seeking to deposit her eggs.

In Chicago, since the great fire of 1871, a large business has been done in transplanting from the woods immense shade trees, some of them over a foot through. The Flat-headed Borer is playing havoc with many of them, and in despair some of my friends have been at the trouble and expense of wrapping the entire trunk and the larger branches in wire gauze, through which the beetle cannot penetrate. This gauze, if so hung that no part of it touched the bark, would undoubtedly prove a perfect protection ; but as it is tacked on, it does not necessarily prevent the female beetle from consigning her eggs to the bark, however much it may prevent the insects already in the tree from issuing; while the cell growth of a single year is very apt to burst it in many places.

But whatever preventive measures be taken, trees should be carefully examined late in the Fall. At this season, or even in the Winter time, the young borers which have just commenced work, are easily detected and destroyed by a knife before they have done much harm. Trees presenting those conditions which I have already stated to be attractive to the insect should be especially watched, and any tree that is suddenly checked in growth should be attended to, as it will probably be found to contain the borer, though the outward signs of its presence may not at first be so manifest. There is a very general impression, also, among orchardists, that this insect is more injurious on low lands than on high lands, and orchards on low land should be more particularly watched.

The presence of the young borer is usually indicated by a discolored spot, a cracking of the bark, or the presence of saw-dust like excrement. It will pay to look over the trees even before Fall, for as early as the latter part of June, in the latitude of St. Louis, the newly hatched worm may sometimes be found just entering, when its presence is frequently indicated by an exuding drop of moisture on the bark, and when it may be destroyed by cleanly cutting out a small slice of bark. Indeed, I would earnestly commend the following advice of Mr. A. A. Briggs, of LeRoy, Barton county, who, after informing me that he has taken out as many as a hundred borers from one small tree, says :

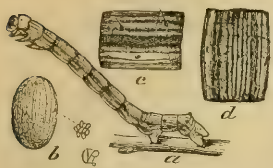
> It is best for those having trees subject to attacks, to look over them every week if possible, or every two weeks at least, from the first of June to Fall, for exudation of sap from the bark, which is a sure indication of their presence. Carelessness in this respect the past season has cost me more than 300 trees, all young.

It is useless to spend time in trying to reach such borers as have already penetrated into the solid wood. They are with difficulty attained, and have already accomplished their principal damage.

CANKER-WORMS.

In further illustration of the remarks made last year on the two species of Canker-worm which have very generally been considered mere varieties of one species, and about which there has been no little confusion,* I have prepared figures of each, which, in connection with a few explanatory remarks, will enable their ready distinction.

[Fig. 14.]



SPRING CANKER-WORM :—*a*, full grown larva ; *b*, egg, enlarged, the natural size shown in the small mass at side; *c*, an enlarged joint, side view ; *d*, do., back view, showing the markings.

THE SPRING CANKER-WORM (*Anisopteryx vernata*, Peck, Figs. 14, 16. This species, which, from the fact that the great bulk of the moths issue from the ground in early spring, may be distinguished from the other by the popular name here given, is the true Canker-worm originally described as *Phalæna vernata* by W. D. Peck in 1795. This is undoubtedly the species for the most part spoken of in the agricultural journals of the country, and the species best known in the Mississippi Valley.† This Spring Canker-worm is distinguished, in the light of recent careful discriminations, by the characters indicated last year, viz.: by each of the first seven joints of the abdomen in both sexes bearing two transverse rows of stiff, red, or reddish-brown, posteriorly directed spines ; by the front wings in the male having three transverse, dusky lines, and a somewhat broader, jagged, pale submarginal line ; and by the whole body in the female,

* This confusion is in part due to the fact that Harris, in his work on Injurious Insects, in treating of THE Canker-worm moth, describes at length, not the species first called the Canker-worm by Peck, but the larger species (*pometaria*). He then uses the following language: "Specimens of a rather smaller size are sometimes found, resembling the figure and description given by Prof. Peck, in which the whitish bands and spots are wanting, and there are three interrupted, dusky lines across the fore-wings, with an oblique, blackish dash near the tip. Perhaps they constitute a different species from that of *the true Canker-worm moth*. Should this be the case, *the latter* may be called *Anisopteryx pometaria*." The term "true Canker-worm" is here misleading, as, while it should evidently apply to the insect originally described by Peck, Harris really applies it to the other species, for which he suggests the name *pometaria*. It is this ambiguity which originally led Mr. Mann to confound the two species, and which led me to make the remarks in the first paragraph on page 29 of my last Report, which—founded on a misunderstanding of Harris's meaning—should be cancelled. As I have already stated, the descriptions in my Second Report are of *vernata*, but the poor figures, which are copied, represent neither species properly, though those of the moths are of *vernata* and those of the eggs *pometaria*. Harris's descriptions of the moths and eggs are of *pometaria*, but those of the larva, and probably of the chrysalis, are of *vernata*.

† There is in fact no evidence that the other species *pometaria* occurs at all either in Illinois or Missouri, since an examination of the specimens in Dr. LeBaron's cabinet and in my own, proves them all to be the true or Spring species. Indeed, until I received specimens of *pometaria* from Mr. H. K. Morrison and Mr. B. P. Mann, I had never seen the species—the male specimens which I mistook for it in former years being in reality specimens of *vernata* which approach it in the markings of the front wings. That it occurs in the Southwest is, however, proved by the fact that Dr. Packard informs me that he has a fine typical specimen from Dallas, Texas, collected by Mr. Boll.

as also the legs and antennæ, being pubescent with pale and dusky hairs—the color being rabbit-gray, or speckled black and white, the abdomen having a medio-dorsal black stripe. The dusky stripes on the front wings of the male, except at costa, and the black stripe on the abdomen, except at each end, are usually more or less obsolete, and indeed the ornamentation of the wings is extremely variable. In many specimens the middle portion of the front wings, within the three dusky lines, is quite pale and mottled with grayish-green, while the basal and terminal portions are marked with brown, thus making the contrast greater. Others again are absolutely without marks whatever, even when fresh from the crysalis; while captured specimens always have the marks more or less effaced on account of the looseness of the scales. The moths rise from the ground for the most part early in Spring, and only rarely the previous Fall. They are crepuscular in habit, and are most active soon after dark in the evening. The female by means of a horny and extensile ovipositor thrusts her eggs, to the number of from 50 to 150, under the loose scales of bark or in any crevice or sheltered place, and is very fond of availing herself for this purpose, of the empty cases of the Rascal Leaf-crumpler* (Rep. 4, Fig. 18.) The eggs are but slightly glued together, and have the form of a rather elongate hen's egg, the shell being very delicate and smooth, though often appearing roughened by transverse and longitudinal, irregular depressions. The larva has but four prolegs, is variable in color, and one of its distinguishing characters is the mottled head (Fig. 15.), and two pale narrow lines along the middle of the back, the space between them usually dark and occupied on the anterior edge and middle of joints 5, 6, 7 and 11 by black marks somewhat in form of X; these marks being represented by dots on the other joints. There are two rather prominent tubercles on top of the eleventh joint, preceded by two white spots. The chrysalis, so far as my comparisons have enabled me to judge, does not differ materially from that of the other species, so that the two species could hardly be distinguished in this

[Fig. 15.]

SPRING CANKER-WORM :—*a*, male moth ; *b*, female do.—natural size ; *c*, joints of her antennæ ; *d*, joint of her abdomen, showing spines ; *e*, her ovipositor—enlarged.

[Fig. 16.]

Enlarged head of Spring Canker-worm, front view.

*Senator Elmer Baldwin, an Illinois orchardist of large experience, as quoted by Dr. LeBaron (2d Ill. Rep. p. 106), found these cases so generally used for this purpose that he considered the gathering and burning of the cases one of the best means of destroying the Canker-worms. I can testify, from my own experience, to the frequency with which the cases are used as a nidi.

state. This is the species treated of in my second Report, and which so injuriously affects our apple orchards.

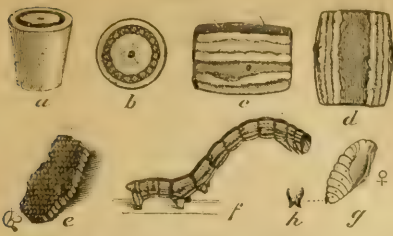
The following descriptions of the immature stages will serve to compare with those presently given of what I call the Fall Canker-worm:

ANISOPTERYX VERNATA, Peck.—*Egg*—Elliptic-ovoid; 0.03 inch long; not quite half as thick, appearing sometimes faintly shagreened, and with irregular, longitudinal depressions; reflecting prismatic colors; shell thin and delicate and quite smooth under the microscope. Deposited in various sized masses in sheltered situations.

Larva—When first hatched of a dark olive-green or brown hue, with a shiny black head and thoracic legs, with a whitish lateral and dorsal band, the latter having a darker central line along it. [These pale stripes are broad, and the dorsal one almost white on the anterior part of each joint, so that the dorsum often appears spotted.] After the first moult, the head becomes lighter and mottled, and the light bands less conspicuous. After the second moult, the bands are almost obliterated and the body becomes more uniformly mottled and speckled with livid-brown; the head becomes still lighter and the prolegs being now large, spread out at almost a level with the venter. After the third (and I believe last) moult, the appearance changes but little. The full-grown larva averages 0.90 inch in length, with an average diameter of 0.10 inch, being broadest on joint 11. It varies from light fleshy-gray to almost black. Head mottled as in figure 16. Ends of body somewhat darker than middle. Joint 1 with a yellowish dorsal shield, the hinder margin in form of a rounded W. Viewed under a lens, the body has a series of eight fine light yellowish, irregular, somewhat broken lines running the whole length of the body, each one relieved by a darker shade each side of it. The two along middle of dorsum are close together, with the space between them usually dark, and occupied at anterior edge and middle of joints 5, 6, 7 and 11 by black marks somewhat in form of x, or of a trefoil; these marks being represented by simple black dots on the other joints. Space between these dorsal lines and the next lowest, lighter, and containing four black piliferous spots to each joint, the posterior ones rather further apart than the anterior ones which on joint 11 form two larger elevated shiny black spots, [often with white spots in front of them.] Space between lines 2 and 3 darker than any other part of the body. That between lines 3 and 4 lighter than any other part of body, and containing the stigmata which are perfectly round and black with a light center, with a small piliferous spot anteriorly above and below them, and another behind them, this last becoming large on joints 5, 6, 7 and 8. Venter dark and livid at borders, with a pale greenish band along the middle, which has a pinkish patch in it on joints 5, 6, 7 and 8. Legs greenish at base; color of body at extremity. The markings are most distinct on the light specimens.—[Second Report.

Chrysalis—Pale grayish-brown, with a dark green tinge on the wing-sheaths. Remarkable for its robustness and for the large size and prominence of the palpi. A single bifurcate thorn at extremity. Length 0.35 inch; diameter across thorax 0.12 inch. (From the fact that in this description of the chrysalis, made six years ago, no reference is made in my notes to any sexual distinction, and that over a dozen chrysalis shells examined all show the wing-sheaths, I infer that the female chrysalis has wing-sheaths, as in *pometaria*, and that it otherwise, in this state, resembles this last.)

[Fig. 17.]



FALL CANKER-WORM:—*a*, *b*, egg, side and top views; *c*, *d*, joints of larva, side and top views, showing markings—enlarged; *e*, batch of eggs; *f*, full-grown larva; *g*, female chrysalis—natural size; *h*, top view of anal tubercle of chrysalis, enlarged.

THE FALL CANKER-WORM (*Anisopteryx pometaria* Harr., Figs. 17, 18.)—This insect is easily distinguished from the preceding, when critically examined. It is, on the average, somewhat larger and more glossy; the front wings of the male have a distinct white spot on the front edge, and are crossed by two pale, jagged bands, along the sides of which there are several blackish dots. The hind wings also have a pale, curved line, more or less distinct, across their middle. The female is uniformly dark ash-gray above, paler beneath, with the antennæ naked, and the legs and abdomen smooth and glistening, and with no extensile ovipositor. Thus it lacks the characteristic spines of *vernata*, the dusky marks across the front wings, and the pubescence in the female; and there are many other minor differences, which are mentioned in the tabular and comparative description of the two insects further on.

The moths rise mostly late in the Fall, but also during the warm weather of Winter, even to Spring. The eggs are tough, with a flattened crown of a purplish color, and having a dimple in the center and a brown ring near the edge: they are not secreted or hidden under scales, but are laid in regular and compact batches, of from 100 to upwards of 200, on the surface of twigs or of the trunk, being fastened by a strong glue, and covered with a slight coating of grayish varnish. The larva is distinguished from that of the Spring Canker-worm by having a dark brown back, and three conspicuous broad, pale yellow lines each side, as well as by having a third pair of prolegs, shorter than the others, on the 8th joint. It develops very rapidly, entering the ground, with favorable weather, within three weeks after hatching; and, singularly enough, suffers but two molts, exclusive of that which takes place underground in transforming to the chrysalis. It is found principally on the Elm, and has not yet been reported from the Mississippi Valley. The female chrysalis is stout and has a little, decurved, bifid thorn on the tip of the body superiorly. It has perfect wing-sheaths, though

[Fig. 18.]

FALL CANKER-WORM—*a*, male moth; *b*, female do.—natural size; *c*, joints of her antennæ; *d*, joint of her abdomen—enlarged.

the moth is wingless. The color is light brown with darker wing sheaths.

ANISOPTERYX POMETARIA Harris—*Egg*—Length, 0.025 inch; average diameter ⅗ the length; flattened at top where it is somewhat larger than at base. Color of crown purplish-gray, the surface slightly corrugated, with a central dimple and a brown circle just within the border; sides smooth and more silvery, and generally somewhat compressed by pressure of adjacent eggs. Laid in exposed situations, in patches or strips, attached in regular rows, and fastened to the bark in a slightly slanting position so that one edge of the crown is a little above, the other a little below the general level.

Larva—Color pale brownish, marked with dark brown and yellow as follows: The dorsum uniformly dark brown; the sides with three pale narrow lines, more or less irregular and mottled, but always well relieved, the two superior ones white, the lowermost yellowish; the subdorsal space between the upper two of these lines, pale; the stigmatal between the lower two darker, especially in middle of the joint around stigmata; the thoracic joints dark with the pale lines somewhat narrower and running up to the head. On joint 11 these lines are constricted or entirely broken, so as to leave a dark band across the middle of the joint. The head is dark brown above and at sides, but paler in front. Cervical shield also dark with the yellow lines running through it. Venter olivaceous, the legs more reddish, there being three pairs of prolegs, the pair on joint 8 only half as long as those on 9, but with perfect hooklets; the thoracic legs quite hirsute and terminating generally in two thorns. Piliferous spots obsolete and with a very few scarcely distinguishable pale hairs, except on anal shield and legs, where they are stouter. Anal shield and legs with brown piliferous dots. The newly hatched larva is pale olive-green with a large pale yellowish head and pale legs. The light lines of the mature larva are, at this early stage, faintly indicated and the piliferous spots give forth short, fleshy, pale hairs. The third pair of prolegs is distinctly visible, but is not used in locomotion. After the first molt the head and thoracic legs become somewhat browner, and the olivaceous green more bluish. After the second molt, the dark colors show much more distinctly.

Described from numerous full grown specimens received from Mr. B. P. Mann, others received from Dr. A. S. Packard, Jr., and a larger number of all ages reared by myself from the egg.

It varies somewhat in intensity of color, and in some the light and dark browns are not so sharply separated, but the dorsum is generally uniform and the three lateral yellow lines distinct. Up to the second or last molt, the general color is, with rare exceptions, greenish; but in the last stage, the dark-brown or black predominates, and is sometimes so general that there is but the faintest trace of the superior yellow lines. Occasional specimens, even when young, show in the subdorsal dark space, one, and in the dorsal dark space, two, very fine and faint pale lines. Differs entirely from *vernata* in lacking most of the characteristic spots in front of the head of that species, and the two pale transverse marks; in having the dorsum darker instead of lighter than the rest of the body; in lacking the medio-dorsal pale lines and the characteristic x-like marks; in the broader, more conspicuous pale lateral lines, and in the subdorsal space being darker than the stigmatal; and lastly in the additional, though atrophied, abdominal prolegs. It is a smoother larva.

Chrysalis—Color light brown, with the wing-sheaths, a medio-dorsal shade, sutures and stigmata darker. Length 0.30—0.35 inch; stout, with the wing-sheaths and their veins distinct in the female; a dorsal, bifid, decurved tubercle near the tip of anal joint.

PRACTICAL CONSIDERATIONS.

The practical man may consider the illustration of these differences as unimportant and trivial, however much they may interest the entomologist. Yet it is of much practical importance to know how to distinguish between these two insects. From present knowledge of the subject, it is highly probable that, just as the moths of the one species appear mostly in early Spring, and of the other mostly late in the Fall, so each is, in a general sense, confined to particular plants—the Spring species preferring our fruit trees, and the Fall species preferring the Elm. Thus the time to put forth our efforts to catch and destroy the wingless moths will vary according to the nature of the tree to be protected and the insect to be dealt with.

In the case of the Spring species, the scraping of loose bark from the tree and otherwise cleansing it of dead leaves, cocoons, larva-cases, etc., a short time before the hatching of the worms, or before the buds of the tree commence to open, will prove an effectual preventive measure; as thereby many of the eggs will be destroyed. Moreover, a tree kept clean of loose bark will be less subject to its attacks. The same argument will not apply to the Fall species, which attaches its eggs in any exposed position. It would seem, also, that the mode of trapping the moths will have to be somewhat modified, according to the species to be dealt with; for while Dr. LeBaron found the tin and rope trap described last year so effectual with the Spring Canker-worm, it does not appear to afford any barrier to the Fall species, judging from the following notes, kindly furnished by Mr. Mann:

Nov. 8, 1873. Warm last night, with rain, which still continues. Found 25 ♀ and one ♂ *pometaria*. Found 4 of the ♀ above the LeBaron zinc band.

Nov. 9. Found 2 ♂, 37 ♀ *pometaria*; 2 ♀ above the zinc band.

Nov. 12. Snow last night, followed by cold sleet. Found 9 ♀ *pometaria*, 1 above the zinc.

Nov. 15. Only 6 ♀ *pometaria*; none above the band. Last three days freezing cold, but not stormy.

Nov. 18. Several days of rain and snow. 1 ♀ *pometaria*.

Nov. 22. 6 ♀, 2 ♂ *pometaria*.

Dec. 4. Yesterday thawing, to-day also. The weather since Nov. 22 has been cold, with occasional snow, and the ground has been frozen, and I have failed to find any *Anisopteryx pometaria*; but to-day I caught 11 ♂, 102 ♀, 2 ♀ above the zinc band. I have no doubt that the smallness of the number of ♀ found above the bands of zinc is due to my promptness and diligence in detecting and destroying them before they have had time to mount the tree; because, according to the theory on which the experiment was tried, the ♀ ought to be found on the outside of the strips, if their ascent has been prevented by them; while in fact, (excluding those found on the house or fence, etc.,) the majority of the ♀ have been caught before they reached the bands; further, because I tried the experiment with 3 or 4 ♀, and found that as soon as they reached the top of the band, they climbed over it, and began to ascend the tree. Being satisfied by this positive evidence, which would outweigh any amount of negative evidence from those who have *not seen it*, I put printers' ink on the outside of the zinc strips. (I

found that the ink was more quickly chilled or dried by being on the zinc, so last Winter I pulled it off and inked paper bands applied closely to the trunk).

Dec. 5. Colder. 25 ♂, 71 ♀ *pometaria.* The greater proportion of the ♂ than formerly is explained by considering that most of them were stuck to the ink; whereas formerly they could hide away by day. It is to be noticed that although some imagos appeared before the frost, they only swarmed after it, justifying the farmers' saying that you must have a frost to bring the Canker-grubs out.

Moreover, it is quite important that the orchardist be able to distinguish these Canker-worms from a number of other looping worms which greatly resemble them, but which produce moths which are winged in both sexes. "For if he mistakes some other span-worm which produces winged females as well as winged males, for the genuine Canker-worm which is apterous in the female moth state, it becomes very obvious that all his efforts to try and prevent the ravages of the spurious Canker-worm by the most approved and well-tried methods, will not only fail most absolutely, but he will lose all faith in such remedies, and may perchance, if he is given to the use of the quill, vent his wrath and disappointment by sending to some one of the horticultural journals of the land, a pithy article 'based upon FACTS [?] and EXPERIENCE,' showing up the utter worthlessness of the Canker-worm remedies!

"It is from such lack of true knowledge that the City Fathers of Baltimore, Maryland, went to the useless expense of furnishing oil troughs for all their large elm trees which were being defoliated, under the delusive idea that the insect committing the ravage was the Canker-worm; whereas it turned out to be the larva of a little imported Beetle (*Galeruca calmariensis*, Fabr.), the female of which has ample wings, and can fly as readily as a bird from tree to tree."—[2nd Rep., p. 95.

I will now give more detailed comparative descriptions of these two insects in their different stages, those of the moths being but slightly altered from the original comparisons drawn up by Mr. Mann, to whom I am under obligations for specimens of *pometaria* in all stages, and for the use of his notes.

ANISOPTERYX VERNATA.	ANISOPTERYX POMETARIA.
Egg.	
Elliptic-ovoid, the shell of delicate texture and quite yielding; generally appearing shagreened or irregularly impressed; nacreous, and laid in irregular masses in secreted places.	Squarely docked at top, with a central puncture and a brown circle near the border; of firm texture, and laid side by side in regular rows and compact batches.
Larva.	
No prolegs on joint 8.	With a pair of short prolegs on joint 8.
Head distinctly mottled and spotted, the top pale, and two pale transverse lines in front.	Head very indistinctly spotted and dark on top.

Body with eight superior, narrow, pale, longitudinal lines barely discernible, the two lowermost much farther apart than the others.	Only six superior broad and very distinct pale lines, those each side equidistant.
Dorsum pale, with median black spots; subdorsal region dark; stigmatal region quite pale.	Dorsum dark, without ornament; subdorsal region pale; stigmatal region dark.
Piliferous spots quite visible and large on joint 11, where the pale lines generally enlarge into white spots immediately in front of them.	Piliferous spots subobsolete.
When newly hatched *dark* olive-green or brown, with black shiny head and cervical shield.	When newly hatched *pale* olive-green, with very pale head and cervical shield.

Chrysalis.

Same as *pometaria*, so far as known.	Stout, the female with wing-sheaths, and a small decurved horn, bifid at extremity near tip of abdomen, superiorly.

Imago.

The first seven joints of the abdomen of both sexes bear each upon the back two transverse rows of stiff, red spines, pointing toward the end of the body.	The first seven joints of the abdomen of both sexes with no spines upon the back.
Front wings of male, on upper surface ash-colored or brownish gray; the whitish spot found on the front wings of *A. pometaria* is wanting.	Front wings of male on upper surface ash-colored with a faint purplish reflection, and with a distinct whitish spot on the front edge near the tip.
The whitish bands found on the front wings of *A. pometaria* are wanting, but there is a jagged, subterminal white band in most specimens, running out to the apex, where it is lined externally with dark brown.	[Front wings] crossed by two jagged whitish bands; the outermost band has an angle near the front edge. The white bands are often entirely wanting, in which case only the whitish spot near the tip remains.
There are three interrupted, dusky lines across the front wings, instead of two pale lines, as in *A. pometaria*. Sometimes these lines are only indicated by dark spots on the costa and by blackish dashes on the median nervure; rarely are they very distinct throughout their whole extent.	Along the sides of the whitish bands there are several blackish dots, each on a nervure, and all generally connected together by a dusky band, which includes them, and runs on that side of each whitish band which is towards the other. These bands remain visible when the whitish bands are wanting.
There is an oblique, blackish dash near the tip of the front wings, crossing a nervure; and there is a distinctly interrupted, or nearly uniform, continuous line of blackish along the outer margin, close to the fringe.	Within the angle of the outermost whitish band, near the costa, there is a short, faint, blackish line, following a nervure; and there is a row of black dots along the outer margin, close to the fringe.
The hind wings are pale ash-colored, or very light gray, with a faint blackish dot near the middle.	The hind wings are pale ash-colored, or light gray, with a faint blackish dot near the middle.
The white band found on the hind wings of *A. pometaria* is wanting.	In most specimens a curved white band is plainly visible on the hind wings, about half way between the middle and the end

On the costa, opposite the beginning of the outermost dark band of the upper surface, and on the edge of the disk, are dusky spots on the lower surface of the wings. Along the median nervure beneath is a dark line. These marks are sometimes indistinct.	The outermost pale band of the front wings, with its angulation, and the band of the hind wings are also visible on the under side of the wings. Within the angulation is a brown or blackish spot on the costa.
	Antennæ of male more serrate and hairy; the serrations darker.
Antennæ of female pubescent with the joints constricted in middle.	Antennæ of the female naked, with the joints only half as long as in *vernata*, and uniform in diameter.
Abdomen terminating in a retractile ovipositor; rather acutely tapering behind.	Abdomen not terminating in an ovipositor; rather bluntly tapering behind.
Whole body and legs of the female pubescent, clothed with whitish and brown or black dentate scales or hairs; general coloration not uniform. A black band along the middle of the back of the abdomen, often interrupted on the second to seventh joints; with a whitish patch each side of its front end; the spines frequently giving a reddish appearance to the part they occupy.	Whole body and legs of the female smooth, clothed with glistening brown and white truncate scales intermixed, giving it an appearance of uniform shiny dark ash-color above and gray beneath.
Crest of prothorax and mesothorax black.	
Of a rather smaller size than *pometaria*, the wings of the male expanding from 0.86—1.30 inches, and the female measuring 0.20—0.35 inch in length.	The wings of the male expand from 1.05–1.35 inches; and the female measures 0.25 to 0.40 inch.

CONCLUSION.

We thus have two distinct species of canker-worms, differing not only in habit, but differing so much structurally in all states (except, perhaps, the chrysalis state) that they may at once be distinguished from each other. In contrast with the soft delicate ovoid eggs secreted in irregular masses, the 10-legged larva, and the spined, and hairy moths of *vernata;* we have the tough, flower-pot-shaped eggs, laid in exposed regular masses, the 12-legged larva and the spineless, smooth moths of *pometaria;* and the specific structural differences are still apparent when we come to examine the genital armature of the males. It is really remarkable that these differences have remained so long unnoticed, especially in those parts of the country where *pometaria* abounds. As a fitting conclusion to what I have written on this subject, it gives me pleasure to be able to reproduce, through the courtesy of Mr. Mann, who copied them for me, portions of the original premium essay on the Canker-worm, by Mr. Peck, not only because of the value and accuracy of the observations, but because they show so conclu-

sively that it was the true or Spring species upon which the essay was based.

Extracts from the original Essay on the Canker-worm, by William Dandridge Peck, published in 1795.

To cultivate a knowledge of insects, merely for their splendid plumage or gorgeous colors, is indeed a contemptible employment; but to inquire into the purposes of their being and the part they are destined to perform in the economy of Nature, is to study the wisdom of that Omniscient Being whose mandates they execute with the greatest exactness. * * * *

These insects (the Canker-worm) appear in the Spring earlier than any other of the moth tribe—about the middle of March. Their rise, however, from the earth will be delayed or hastened according to the temperature of the atmosphere and state of the soil. They are found under a double form, the males being furnished with, and the females being destitute of, wings. This circumstance necessitates the females to ascend the tree by its trunk in order to deposit their eggs upon the branches. The males by their wings resort to them, and are found in the evenings hovering round the trees. In three or four days after they begin to rise, they are found sub-copula. This office is performed in eleven or twelve days after their first appearance. The males die and disappear. In thirteen days the females deposit their eggs. These they place in the crannies of the bark in the forks of small branches; and where there are spots of moss upon the smaller limbs they seem most fond of insinuating themselves into the cavities between its leaves. For this purpose the females are furnished with a tube through which the egg is passed, with which she investigates the appertures in the bark or moss, and ascertains their depth. * * * Each female lays at a medium an hundred eggs. The ultimate purpose of their being thus performed, they die.

The egg is elliptic, 1-30 of an inch in length, of a pearl color, with a yellowish cast. As the included animal advances in ripeness the egg assumes a brownish hue; in twenty days is of a lead color, and with a moderate magnifier the larva may be seen to move in the shell. On the twenty-first day the larva breaks from its prison, is one line in length, and furnished with ten feet—six anterior and four posterior. * * * They are commonly hatched about the time that the *red currant* is in blossom, and the apple-tree puts forth its tender leaves. * * *

On the twenty-sixth day from their quitting the egg they begin to cease from feeding and descend by the trunk of the tree; when arrived at its foot they with great labor penetrate the earth near it to different depths; and this appears to depend in part on the quality of the soil and in part on the vigor of the animal. In grass land they are found from one to four inches beneath the surface, and when the trees stand in plowed land, if the soil be loose, they penetrate to the depth of seven or eight. * * *

It has been observed above that they descend by the trunk of the tree; all which descend in this manner enter the earth near it. This is their natural and regular course, and hence the greatest number of them is found within a circle, whose radius extends four feet from the trunk. But some will always be found at a greater distance, according to the area which the tree covers; for if dislodged by wind or accident at the time when they are about to seek the earth, they cover themselves near the spot they fall on. In recurring to the structure of the female insect we see at once the reason why they are naturally confined to a small circle.

The larva or catterpillar is, when full grown, about nine lines long; the head pale,

marked on each side with two transverse blackish stripes; the back ash-colored, marked lengthwise with small, interrupted dusky lines; the sides blackish, with a pale line along the length of the body; there are two white spots on the last segment of the body; the abdomen or underside is ash-colored. * * *

The chrysalis state comes on in twenty-four hours after the larva has penetrated the earth; and it appears that the insect is soon perfect, since a course of warm weather has been found to raise some of them from the earth in the month of November. While they are in chrysalis they are uninjured by frost. Their natural and regular time of rising is about the middle of March, but happens sometimes as early as the twelfth, and is sometimes retarded to the twenty-fourth, according to the warmth or coldness of the season. They continue to rise for a longer or shorter time, according to the greater or less depth at which they lie, and the extrication of the frost from the earth—commonly from twenty to thirty days. * * * Like others of the moth kind, they are active only in the night, and in the day time sit close to the bark of the tree, whose color is so similar to theirs that they are not seen without near inspection. * * *

The principal check provided by Nature, upon the too great increase of this insect is the *Ampelis garrulus* of Linnæus, called by Mr. Catesby, the Chatterer of Carolina, and in the Rev. Doctor Belknap's History of New Hampshire, Cherry-bird. This bird destroys great numbers of them while in the larva state. Another check is a disease which may be called *Deliquium*, and is probably occasioned by a fermentation of their food. In this disease the whole internal structure is dissolved into a liquid, and nothing is entire but the exterior cuticle, which breaks on being touched.

The Canker-worm is said to have been observed first in the Southern States, where it is probably a native. It is certain it must be spread by some means independent of itself, since the female, by the privation of wings, is forbidden to range.

It may have been introduced into New England by the importation of trees from the Southern States, on which the eggs were deposited; or disseminated in the larva state, in all populous parts of the United States, by falling from trees upon carriages and travelers passing under them.

This conjecture is rendered probable by its being found in all places which have intercourse with such parts as are infected with it, and by its being unknown in new settlements.

THE GRAPE PHYLLOXERA.

The following notes on this insect are intended to supplement the article in the Sixth Report, and should be read in connection with said article. It is my desire to give a record of observations and discoveries, in the matter of Phylloxera, with as little repetition of what has previously appeared in these reports, as is consistent with intelligibility.

COMPLETION OF ITS NATURAL HISTORY.

During the year the natural history of the species has been all but completed; as I predicted it would be, after Balbiani had paved

the way by his remarkable biological studies of the European Oak Phylloxera, made a year ago. It turns out, as was expected, that the Grape Phylloxera agrees with its oak congener in producing wingless and mouthless males and females; and the problematic winged individuals, with short bodies and relatively long wings and members, which individuals were looked upon by myself and others as the possible males, must necessarily be abnormal females.* The sexual individuals have now been traced in the Oak and Grape species (*quercus* and *vastatrix*) in Europe by Balbiani; and I have traced them in three species (*Rileyi*, *vastatrix* and what is probably *caryæcaulis*) in this country.

The life-history of the Grape Phylloxera may be thus epitomized: It hibernates mostly as a young larva (Rep. 6, Fig. 5,) torpidly attached to the roots, and so deepened in color as generally to be of a dull brassy-brown, and, therefore, with difficulty perceived, as the roots are often of the same color. With the renewal of vine-growth in the Spring, this larva molts, rapidly increases in size, and soon commences laying eggs. These eggs in due time give birth to young, which soon become virginal, egg-laying mothers, like the first; and, like them, always remain wingless. Five or six generations of these parthenogenetic, egg-bearing, apterous mothers follow each other; when—about the middle of July, in this latitude—some of the individuals begin to acquire wings† These are all females, and, like the wingless mothers, they are parthenogenetic. Having issued from the ground, while in the pupa state, they rise in the air and spread to new vineyards, where they deliver themselves of their issue in the form of eggs‡ or egg-like bodies—usually two or three in number, and not

* Balbiani (*Comptes Rendus Ac. d. Sc.*, Paris, September 21, 1874,) after a careful examination of these individuals, says that they play no special physiological rôle in the phenomena of reproduction; but that they have all the characters of the normal winged females, with, however, the generative organs atrophied; and may, in part, be compared to the neuters among bees and ants.

† During this virginal reproduction a gradual reduction in vitality and prolificacy is observable from generation to generation. Around the first virginal mother the eggs may accumulate by the hundred; but they decrease in number in succeeding generations until the individuals which—whether winged or wingless—lay the sexual eggs, give birth in no instance, yet recorded, to more than eight. From the true female again, or at the end of the cycle, only a solitary egg is born.

‡ It has been a question whether the egg-like bodies from these winged females, or from the wingless mothers which produce them, can properly be called eggs, and M. Lichtenstein has proposed to call them pupæ, because they give birth, not to a larva but a perfect insect. The term "pupa" is, however, manifestly incorrect as applied to these bodies, because, when first laid, they are transparent with a homogeneous content; while the sexual individual develops within the covering very much as the embryonic larva develops within the egg. In fact we have here, not, as in *Hippobosca*, a larva hatching and nourished in the ♀ abdomen until full grown and contracting to a pupa before delivered; but an insect hatching and undergoing its entire development within the egg-covering after the egg is delivered. Thus while the covering might more properly be called a sac just before the male or female creeps out of it, it is more truly an egg when first delivered; and so it is best to call it.

exceeding eight—and then perish. These eggs are of two sizes, the larger about 0.02 inch long and the smaller about three-fifths of that length. In the course of a fortnight they produce the sexual individuals, the larger ones giving birth to females, the smaller to males. These sexual individuals are born for no other purpose than the reproduction of their kind, and are without means of flight, or of taking food, or excreting. They are quite active and couple readily; one male being capable, no doubt, of serving several females, as Balbiani found to be the case with the European *quercus*. The abdomen of the female, after impregnation, enlarges somewhat, and she is soon delivered of a solitary egg, which differs from the ordinary eggs of the parthenogenetic mother only in becoming somewhat darker. This impregnated egg gives birth to a young louse which becomes a virginal, egg-bearing, wingless mother, and thus recommences the cycle of the species' evolution. But one of the most important discoveries of Balbiani is that, during the latter part of the season, many of the wingless, hypogean mothers perform the very same function as the winged ones; *i. e.*, they lay a few eggs which are of two sizes, and which produce males and females, organized and constructed precisely as those born of the winged females, and, like them, producing the solitary impregnated egg. Thus, the interesting fact is established that even the winged form, is by no means essential to the perpetuation of the species; but that, if all such winged individuals were destroyed as fast as they issue from the ground, the species could still go on multiplying in a vineyard from year to year. We have, therefore, the spectacle of an underground insect possessing the power of continued existence, even when confined to its subterranean retreats. It spreads in the wingless state from vine to vine and from vineyard to vineyard, when these are adjacent, either through passages in the ground itself, or over the surface. At the same time it is able, in the winged condition, to migrate to much more distant points. The winged females, as before stated, begin to appear in July, and continue to issue from the ground until vine growth ceases in the Fall. Yet they are much more abundant in August than during any other month, and on certain days may be said to literally swarm. Every piece of root a few inches long, and having rootlets, taken from an infested vine at this season, will present a goodly proportion of pupæ; and an ordinary quart preserve jar, filled with such roots and tightly closed, will furnish daily, for two or three weeks, a dozen or more of the winged females, which gather on the sides of the jar toward the light. We may get some idea, from this fact, of the

immense numbers that disperse through the air to new fields, from a single acre of infected vines, in the course of the late Summer and Fall months.

If to the above account we add that occasionally individuals abandon their normal underground habit, and form galls upon the leaves of certain varieties of grape-vine, we have, in a general way, the whole natural history of the species.

DIFFERENT FORMS PRESENTED BY THE SPECIES.

The differences in form and habit which the species presents will be best appreciated by recapitulating them in tabulated form:

1—The gall-inhabiting type (*gallicola*—Sixth Rep., Fig. 4,) forming galls on the leaves, and presenting:
- *a*—The ordinary egg (*ibid*, Fig. 4, *c*,) with which the gall is crowded:
  - *b*—The ordinary larva (*ibid*, Fig. 4, *a*, *b*):
    - *c*—The swollen, parthenogenetic mother, without tubercles (*ibid*, Fig. 4, *f*, *g*, *h*):

2—The root-inhabiting type (*radicicola*, Sixth Rep., Fig. 5,) forming knots on the roots, and presenting:
- *aa*—The ordinary egg, differing in nothing from *a*, except in its slightly larger average size:
  - *bb*—The ordinary larva, also differing in no respect from *b*:
    - *d*—The parthenogenetic, wingless mother, the analogue of *c*, but covered with tubercles (*ibid*, Fig. 5, *f*, *g*):
    - *e*—The more oval form, destined to become winged (*ibid*, Fig. 5, *e*):
    - *f*—The pupa, presenting two different appearances (*ibid*, Fig. 6, *e*, *f*, and Fig. 8, *a*):
    - *g*—The winged, parthenogenetic female, also presenting two different appearances (*ibid*, Fig. 6, *g*, *h*, and Fig. 8, *b*):
- *h*—The sexual egg or sac deposited by *g*, being of two sizes, and giving birth to the true males and females:
    - *i*—The male:
    - *j*—The true female:
- *k*—The solitary impregnated egg deposited by *j*:
  - *bbb*—The larva hatched from *k*, which, so far as known, does not differ from the ordinary larva, except in its greater prolificacy:
  - *l*—The hibernating larva (*ibid*, Fig. 5 *b*), which differs only from *b* in being rougher and darker.

Thus the insect is found in at least a dozen distinct forms, excluding the variation that some of these forms are subject to; while, in addition to what we already know of its power to change its habit, I will add that Balbiani reports having succeeded, by gradually accustoming the species to new conditions, in making the progeny of the root-louse live above ground, where, singularly enough, they did not

form galls, but dwelt on the under side of the leaves like the Oak species. This change of habit was brought about after the third generation; and while it may probably never occur in nature, and finds its parallel in the well-known instances of rearing several generations on a thick piece of root in tubes and bottles, yet it forcibly illustrates the power of adaptation and change which the species possesses. It may be also stated in this connection, that Dr. L. Rössler, of Klosterneuburg, Austria, has found the insect, of all sizes, above ground, under the loose bark near the base of the vine—a position which is quite exceptional for it to assume.

SPECIFIC IDENTITY OF THE GALL-INHABITING AND LEAF-INHABITING TYPES.

The reader of these reports will scarcely need to be told that the two types above mentioned are identical; but as the fact has been called in question by a few of our prominent grape-growers, I repeat here what I wrote on the subject not long since for the New York *Tribune*:

In the October number of the monthly report from the Department of Agriculture at Washington, there is the record of an experiment by Townend Glover, Entomologist to the Department, the object of which is, in Mr. Glover's language, "to prove the identity of the Pemphygus [Pemphigus] vitifoliæ or leaf-gall-louse, of Fitch, with the Phylloxera vastatrix, or root-gall-louse,* so injurious at present to the vineyards in France, and in parts of this country also." This is the experiment referred to in the *Tribune* of the first week of March last, and the item detailing it, shows, as I had anticipated, that no galls were produced. It also shows that "we cannot give the names of the vines [experimented with] as accidentally the labels were thrown away by the laborer when he removed the dead vines," and, though closing with a confession that the experiment decides little or nothing, it nevertheless appears to strengthen the belief held by many, that the leaf louse and root-louse are not specifically identical.

The item has been very generally copied in our agricultural papers, and has been widely disseminated over the country, through the monthly report, in which it first appeared. The average editor and the average reader of our agricultural and horticultural journals have not, nor can they be expected to have, nor do they pretend to have, profound knowledge in every specialty; and for these reasons items of this kind, coming from the fountain head, have a great in-

* This term, which is original with Mr. Glover, should be discountenanced, as the term "gall," strictly speaking, applies only to abnormal vegetable growths, caused by insects dwelling within them; and not to mere swellings induced by insects which always live exposed.

fluence in shaping popular opinion. It is all the more necessary, therefore, that information coming from such a source be trustworthy.

The ostensible object of the experiment described, was to prove the identity of the Phylloxera which forms galls on the leaves of the Grape-vine, with that which causes the swelling and rotting of the roots of the same plant. The inference from the attempt is, that the two forms had not so far been proved specifically identical. Yet the question had long since been settled by eminent observers, whose care and thoroughness have won for them respect and authority. Already in 1868, that eminent entomologist, J. O. Westwood, of England, who examined both types, announced that he could not perceive in them specific difference, and in the Fall of 1870, the specific identity of the two types was proved by myself, by obtaining root-lice (*radicicola*) direct from gall-lice (*gallicola*), and by showing that the young of the latter as they are carried to the ground by the fall of the leaf, creep on to the roots to hibernate, and there assume the characters of the root-inhabiting type. But anterior to my own experiments, the specific identity of the two types was thoroughly proved by three different and independent observers in France, and their observations are on record in different numbers of the *Messager du Midi*. Since then the identity of the two types has been confirmed in the most conclusive and emphatic manner by several observers, Maxime Cornu, more especially, having recorded in detail, in the *Comptes Rendus* of the Paris Academy of Science, his thorough and painstaking experiments, in which he not only institutes the most careful and anatomical comparisons, but records having actually watched the process of change from the one to the other. These articles, though originally appearing in the *Comptes Rendus*, have been copied in more popular works, while the facts have been recorded in this country. Finally, the specific interrelation of the two types was still more firmly established last Winter by the production of an abortive gall from a root-louse.*

Indeed, the question has for some time been considered definitely settled by all who are well informed on the subject. Yet while further proof of the identity of the two types was scarcely necessary, all endeavors by experiment to obtain gall-lice from root-lice are praiseworthy and interesting, if they are carefully made. But the value of experiments like those made at Washington, where no intelligent choice is made of the particular varieties of vine employed, and where not even the names of the varieties are known, will appear from the following facts, which are well understood by all who have kept au

* See Sixth Mo. Rep., p. 41.

courant of the Phylloxera question: The gall-inhabiting type of the Grape Phylloxera is but a dimorphic, agamous and apterous female form, never becoming winged, never producing any males, and not at all necessary to the perpetuation of the species. It can only flourish on a few varieties of vine, and on the others it makes abortive attempts or no attempts at all to found galls. In short, there are but few among the many cultivated varieties of the Grape-vine upon the leaves of which the Grape Phylloxera—under conditions which we shall probably never understand—can form galls; while on the large majority of our varieties, such as Norton's, Catawba, Gœthe, Diana, Cunningham, Iona, Isabella, Martha, Maxatawney, Ives, North Carolina, etc., we may justly conclude that the insect cannot form galls, since galls are never found upon them. The attempt, therefore, to make the insect produce galls upon such vines must necessarily prove futile, and in the light of present knowledge, the first requisite in any experiment having such object, should be an intelligent choice of varieties.

Even where those vines are employed—as Clinton and varieties of *Riparia* and *Cordifolia*—upon which galls can be most readily produced, the experiment of producing galls upon them from root lice, will not be likely to succeed, and the failure to thus produce galls must count for little or nothing against the results already obtained.

The gall-louse is but a transient form, by no means essential to the existence of the species, and its existence depends not alone on the nature of the vine, but, as already stated, on other yet unknown conditions, which cause it to be abundant on a vine one year and perhaps entirely absent the year following. Now, these conditions may not obtain in one out of a hundred experiments, and the number of fruitless efforts properly and intelligently made to obtain these galls, both in Europe and this country, attest the difficulty here encountered. I have even found the greatest difficulty in producing galls from the progeny of the gall insects themselves, in my experiments in-doors.

Loose experiments, especially when, as in this instance, they convey wrong impressions, do more harm than good. I hope, therefore, that the facts here stated will serve to offset the article in the Department Reports.

WHERE DO THE WINGED FEMALES LAY THEIR EGGS?

Last Fall I was not a little surprised by a letter from my friend Lichtenstein, of Montpellier, France, under date of September 6th, announcing the fact that he had just discovered that the winged Grape Phylloxeræ congregate in immense numbers on the leaves of the Chermes Oak (*Quercus coccifera*), a small shrubby tree growing on

the higher lands of that country: further, that they make a nidus of this tree, to the leaves of which they consign the few eggs in their abdomen. Notwithstanding my high appreciation of his knowledge regarding the different species of Phylloxera, I immediately wrote to my friend that he must be wrong, as we have no Chermes Oak in America, and I had never found the winged Grape Phylloxera upon any of our oaks, though I had frequently beaten it in August from vines. From an examination of specimens which accompanied the letter, I suggested that he had mistaken the European Oak species (*quercus* Fonsc.) for the Grape species (*vastatrix*). Subsequent careful studies by Balbiani and others, proved this suggestion to be correct. Yet M. Lichtenstein still believes that he not only found the winged females of two species that infest the Oak there, but that among them there were some of the Grape-vine species. In that event, the following conclusions are inevitable: 1st, as the Chermes Oak does not occur here, the winged Grape Phylloxera in America, and in all countries outside the range of that oak, must make a nidus of some other tree; 2d, the young (progeny of the sexual individuals) brought forth on such trees when they are far away from vineyards, must inevitably perish; because they are not winged, and have feeble power of locomotion. From the fact that I have beaten from our Post Oak, a large winged Phylloxera answering to the description of *Ph. caryæcaulis* Fitch, which makes a large, irregular, smooth gall on the leaf-stalk of the Bitternut Hickory, and which certainly does not inhabit oak trees, I am the more disposed to believe that chance individuals of the Grape species may also be found on oaks,* and am thus forced to the following conclusions: The winged females of Phylloxera (and the same will hold true of two allied genera—*Pemphigus* and *Eriosoma*) are not drawn by instinct to any particular plant, but are wafted about and will lay their eggs, or, in other words, deliver themselves of their issue, wherever they happen to settle. If this is upon their proper food-plant, well and good; the young live and propagate: if not, they perish. We should thus have the spectacle of the species wasting itself to a greater or

* This hap-hazard, wandering habit is well known to belong to several closely allied Aphidians, and the winged female of *Pemphigus vagabundus* Walsh, which forms a large coxcomb-like gall on the Cottonwood, and can breed on no other tree, is often found in the Fall of the year so abundantly on all kinds of trees and shrubs—as every entomologist in the habit of "beating" is aware—that it was named in consequence of this wandering habit. I have reason to believe that in *Pemphigus* as in *Phylloxera*, the winged females give birth in the Autumn, after leaving their galls, to wingless sexual individuals whose issue must naturally perish on all trees except Cottonwoods.

less extent, just as most plants annually produce a superabundance of seed, the larger proportion of which is destined to perish. From a large number of facts that have come to my knowledge in insect-life I actually believe this to be the case; and, if so, it adds one more weighty reason to those I have already given why the insect is so injurious in France, and explains its rapid multiplication in the thickly planted vine districts of that country. There, few winged insects would fail to settle where their issue could survive; while in our country there must be, on this hypothesis, an immense number annually perishing in the large tracts of other vegetation between our scattering vineyards.

The particular part of the vine chosen by these winged mothers, when they settle in a vineyard, for the deposition of their eggs, has not yet been definitely ascertained. "In confinement I have had such eggs deposited both on the leaves and on the buds, and from the preference which, in ovipositing, these aerial mothers showed for little balls of cotton placed in the corners of their cages, I infer that the more tomentose portions of the vine, such as the bud, or the base of a leaf-stem, furnish the most appropriate and desirable *nidi*. On this hypothesis it is quite possible for the insect to be introduced from vineyard to vineyard, or from country to country, as well upon cuttings as upon roots."—[6th Rep. p. 46. So I wrote a year ago; but while these eggs may frequently be laid upon the vine itself, I am now disposed to believe that they are more often laid in the minute cracks and interstices on the surface of the ground, especially near the base of the vine; for where I have had the females confined in tubes or bottles half filled with moist earth, they have often deposited in the interstices at the sides of the vessel, and, as Balbiani has remarked, the constant elongation of the abdomen, and tentative motion of the tip from side to side, which is common to these winged mothers, rather indicate search for some such positions.

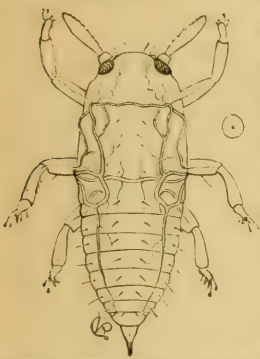
THE SEXUAL INDIVIDUALS.

We have seen that the winged females abound, especially during August, and that they deliver themselves freely of their egg-like contents. They are quite active during the warmer parts of the day and are comparatively short-lived, at least in confinement, where they usually die along side their eggs. These eggs are twice as long as wide, the larger ones, which produce females, about 0.025 inch and the smaller 0.018 inch long. They are quite pale and translucent and soon begin to show the reddish eyes of the embryon within. They hatch,

however, with great difficulty in confinement; and though I have had several hundreds under my care at one and the same time, in tubes and in jars, with and without moist earth, yet I have succeeded in getting but two females to hatch; though many of them if mounted in balsam before life departs and they become discolored, will show the characters of the enclosed animal with tolerable distinctness. Balbiani found the same difficulty in hatching these sexual eggs from the winged females; but had better luck with those from the wingless underground individuals, which seemed to hatch more readily.

These sexual individuals are, as already stated, entirely destitute of mouth-parts, and have simply, in their stead, a little tubercle where the proboscis of the other individuals originates. The male is readily distinguished by the penis which extends from the tip of the abdomen, and is bulbous at base, but terminates in a sharp point. The female is distinguished by the pedunculated third joint of her antennæ, but except in these striking characters, they bear a close resemblance to the ordinary larva. I introduce in illustration of the male, a dorsal figure of the male of a larger species (probably *carycæcaulis* Fitch*) the mounted specimen of which is a better subject to figure than those from *vastatrix;* and in connection with the ventral view given further on of the male of the American Oak Phylloxera, will convey a sufficiently exact impression.

[Fig. 19.]



MALE PHYLLOXERA: the dot within circle showing natural size.

INJURY DONE DURING THE YEAR IN AMERICA.

The Phylloxera was less numerous and did less injury in 1874 than in any of the three previous years. This was owing principally to the fact that there was a good deal of wet weather in the Spring, though it was unusually dry in most parts of the State later in the season. The grape crop was unusually good, the character of the wine also superior. Yet, notwithstanding the excellence of the average crop of the

* This was obtained from some large winged females, beaten, the latter part of September, from some small Post Oaks. From a comparison with the described N. A. species, I take it to be the *Ph. carycæcaulis* Fitch, which forms galls on the petiole of the leaf of the *Carya glabra* (see Synopsis, further on). The winged ♀ is more than twice as large as *vastatrix,* with much blacker mesothoracic band, duskier shades on the head, and duskier wings and members. The male is quite pale in color, 0.02 inch long, with the claws and digituli rather small; but agreeing very closely in structure with the male of *Rileyi,* except in the conspicuousness of the nerves which show through the transparent skin in the manner indicated in the figure,

State—notwithstanding the fact that the Catawba and many other of the more susceptible vines did better than usual; the injury from Phylloxera was often quite apparent in the Fall, and I know of a four-year old Gœthe vineyard in St. Louis county which gave great promise a year ago but which had about succumbed in September; half the vines being at the point of death, and most of them showing the acute symptoms, with the finer roots all wasted away and the larger ones covered with the lice, as completely as is usual with European vines. Such facts serve to show that the insect is by no means destroyed even where, as in 1874, it is with difficulty found in early Spring. Here, therefore, let me reiterate, what cannot too often be repeated, that while only very careful search will detect the insect at the awakening of Spring, and its presence is best indicated by the swollen and rotting roots wherever it has been at work; yet it multiplies so rapidly that in midsummer and Autumn a casual examination will generally reveal it in great numbers on infested vines. I wish to impress this fact for the simple reason that in several instances where correspondents reported no trace of Phylloxera on their vines last Spring, I subsequently showed them abundant evidence of its presence, evidence which at once dispelled their skepticism. While my observations were confined for the most part to our own State, and more especially to St. Louis county, the following valuable letter of experience will show that intelligent grape-growers are recognizing its work in other States:

MY DEAR SIR: I beg you will pardon my tardy acknowledgment of your polite attention in sending me your very interesting, and, I may say, almost exhaustive report upon the Grape Phylloxera. Although I have been, in a casual way, observing the leaf-infesting form of this Aphid since 1861, I find much that is new to me in your paper; but I am obliged to say, so far as my observations have extended, that they accord almost identically with yours. I did not then even suspect the presence of the root-louse; not indeed until I had seen some account of your investigations. * * * From the increase of its insect-enemies, or from some other cause, the gall-louse has entirely disappeared from this section, and vines formerly infested are now wholly exempt. I wish I could say as much for the root-louse. I hardly think the latter increasing, but he certainly seems to "hold his own." I have one vine, a seedling from Concord, which I call "Lady," a white variety, which, so far, has been entirely exempt from its attacks. From its parentage, I should expect it successfully to resist serious injury, but not to enjoy exemption. Either from some native hardiness, or because it is not entirely to its taste, I have found Concord not injured much even when infested, and only the small, fibrous roots attacked. To a considerable extent, Hartford, Ives, Telegraph, and this class of vines seem able to resist and overcome the attacks of the root-louse, when the various kinds known as "hybrids" succumb, as well as Iona, Catawba, and others of that class. I am well satisfied this root-louse is the most serious of all the enemies the grape-grower has to contend with, and I believe it has been the cause of many failures which seemed unaccountable. As a matter of curiosity, I will send you copy of a letter to the *N. Y. Tribune* in 1863.

Truly yours,
GEO. W. CAMPBELL.

DELAWARE, OHIO, December 23, 1874.

The letter to the *N. Y. Tribune*, referred to by Mr. Campbell, and written in 1863, gives an interesting account of the gall-inhabiting type, and its effect on the leaves.

In addition to the foregoing in illustration of the insect's injuries in America even during a most favorable year for vine growth, our horticultural literature has given further evidence of the same character. Mr. F. R. Elliott, for instance, one of our most prominent horticultural writers, and ex-Secretary of the American Pomological Society, has had much to say during the year about the acknowledged feebleness and failure of many varieties, and among them the Eumelan, Wilder, Catawba and Isabella. But he attributes the trouble to injudicious methods of propagation, and lays the blame to the door of the nurserymen, who, he asserts, in their avidity for gain, have sent out wood that was immature and lacked vitality. His ideas have been very generally, and, I think, successfully repudiated; and, in fact, his argument ought to apply to all varieties—those which succeed as well as those which fail; and while in some few instances there may be foundation for them, I cannot help thinking that the work of Phylloxera has had much more to do with the general feebleness and failure of such varieties.

It must not be forgotten that the character of the soil has very much to do in furthering or impeding the injury from Phylloxera, and that the successful growth of susceptible varieties—as of the Delaware around Warrensburg—may often be accounted for by the sandy nature of the soil; for the insect cannot multiply in such a soil, to the extent it can in one less yielding and more apt to form fissures, crevices and passage-ways.*

RANGE OF THE INSECT IN AMERICA.

Under this head, after showing that the insect is indigenous to the United States east of the Rocky Mountains, I wrote, last year, as follows: "I have myself found it in Kansas, Iowa, Illinois, Missouri, Michigan, Ontario, New York, New Jersey, Pennsylvania and Maryland, and have good evidence of its occurrence in Connecticut, District of Columbia, North Carolina, Texas, and as far south as Florida. It doubtless occurs in all the intermediate States." Its occurrence in Connecticut can now be affirmed; for I found it around Hartford, and upon being informed by Mr. H. T. Bassett, of Waterbury, that he had certain vines which were sickly, I repaired thither with him, and the very first roots obtained revealed the enemy and its work. Yet

* As bearing on this point, in addition to what I have said in previous years, Mr. Chas. Teubner, of Hermann, who, in a communication read at the last annual meeting of our State Horticultural Society, reports most grapes as doing well, and insects less injurious than usual, remarks that "in locations where the soil was sandy, grapes did best in every respect, and it is my opinion that to use sand freely in a vineyard (where it can be got) will materially aid in diminishing disease, and bringing the vines into a flourishing condition."

it certainty does not occur in many parts of Georgia and South Carolina, as is plainly indicated by the following letters which I give entire, because they show how thorough were the observations, and describe the character of the soils in which said observations were made. Yet I have such faith in the general distribution of the insect in the country east of the Rocky Mountains that I fully expect that it will yet be found even in Georgia and South Carolina; and I half suspect that the failure of Messrs. Ravenel and Berckmans to find it, is owing perhaps more to an exceptional season, unfavorable to its development, than to its non-existence there. However, suspecting is not knowing, and here are the facts, as they are given:

DEAR SIR: I am in receipt of yours of 25th inst., requesting me to give you the result of my various examinations for Phylloxera.

Having been appointed by the American Pomological Society at the Boston meeting last year, one of a committee to examine and report in regard to the matter, I have made this season as careful and comprehensive an examination as I could well do. What I had to say on the subject has been already sent on to one of the committee to be embodied in the report. As it consists simply of the results of my examination, a statement of the facts which came under my observation, I will very cheerfully repeat them here. I confess to a surprise at not finding a Phylloxera, but yet I feel perfectly satisfied that my examinations were as careful and thorough as it was possible. I offer no opinion, but give simply a statement of facts taken from my notes made at the time.

June 15, 1874—Examined to-day 4 Isabella and 1 Black July vine, and also 1 Warren, (Herbemont,) in my garden; all old vines. I could find no trace of insect life, neither eggs nor young lice upon the young rootlets, nor the effects of former ravages on the older roots.

June 17, 1874—Examined the following in vineyard of Rev. T. H. Cornish, and with his assistance, viz.: 5 Chasselas de Fontainbleaux, 1 Muscat of Alexandria, 2 Catawba, 1 Pauline and 1 Isabella.

These vines are from twelve to fifteen years old, generally quite healthy and the fruit, up to a few days ago, free of rot; now more rot on the Warren. No trace of insect life on the young, or on older roots, or on any of them.

July 24, 1874—Examined 2 Isabella and 1 Warren in my own garden; and in Mr. Cornish's vineyard, 1 Chasselas, 1 Muscat of Alexandria, 1 Catawba and 3 Warren. Found nothing.

Aug. 22, 1874—Examined 2 Isabellas in my own garden; found nothing.

Sept. 9, 1874—Went over to Mr. Berckmans' *Fruitland Nursery*, near Augusta, Georgia, and made an examination of vines in various parts of his grounds, of several different varieties and under different modes of cultivation. I had the benefit of Mr. de Hardy's assistance in all my examinations, as he had seen the Phylloxera in France and was familiar with its appearance, and the effects of its ravages. In each case the whole vine was dug up carefully and the roots subjected to a close and scrutinizing examination. We found no trace whatever of the insects, nor the effect of any ravages in previous years upon the older roots. We took specimens from 7 different vineyards, some under cultivation and others thrown out for a year or two.

1 Israella, 7 years old, uncultivated for one year.
1 Clinton, 12 years old, uncultivated for one year.
1 Clinton, 3 years old, under cultivation.
1 Catawba, 15 years old, out of cultivation two years.
1 Golden Clinton, 4 years old,
1 Concord, 3 years old,
1 Wilder, 3 years old,
1 Northern Muscatine, 3 years old,
1 White Riesling, 3 years old,
} Under cultivation.
1 Taylor, 4 years old, cultivated.
1 Alvey, 6 years old, uncultivated for one year.

The above is simply a transcript from my notes, and is at your disposal. I feel satisfied that had the Phylloxera been present, it could not have escaped my observa-

tions, and I can safely say, that it was *not infesting* the vines which came under my examination.

Very truly yours, H. W. RAVENEL.

AIKEN, S. C., November 30, 1874.

In yours of the 5th inst., received yesterday, you inquire about the character of the soils in which I examined grape vines. There were three localities:

First. My own lot in Aiken, into which I moved a year ago, and found there vines growing. This is a light (extremely light) sandy soil, clay from eight to ten feet beneath. We are just on the border of the "Sandhill" region, a belt of four sand hills, running about 100 miles parallel with the sea coast, about ten to fifteen miles wide, and extending from North Carolina, through South Carolina into Georgia.

Second. Rev. Mr. Cornish's vineyard has more clay, but could not be called a clay soil, perhaps only a good admixture.

Third. Berckmans' "Fruitland," four miles west of Augusta, is a red, or rather brownish soil, with just clay enough to make a freable loam, made darker of course by manurings, and containing a vast quantity of rounded pebbles, intermixed, from one to two or three inches in diameter. I think that these three soils represent the soils most commonly in cultivation. * * *

Yours, cordially, H. W. RAVENEL.

AIKEN, S. C., December 11, 1874.

DEAR SIR: I am glad Mr. Ravenel gave you a detailed account of his observations. Last September he spent some days with me, and we visited several localities, and carefully investigated many vines from 1 to 15 years old. Since then I have examined vines in Atlanta, some 15 varieties, Æstivales and Labruscas, but no signs of Phylloxera. Soil there quite compact; a clayey loam. On my place the soil is of mixed character. The whole tract is underlaid with a red clay subsoil, except in my low lands, which are alluvial. A portion, 300 acres, is what is termed here "Mulatto land," a rich loam of about 18 to 24 inches deep. Another portion is mixed with gravel and red clay subsoil, and a small portion is more sandy. All my land is what is called here red land, in contradistinction to the sandy region, which is called grey land. One mile from my house is a creek. On my side the subsoil is red clay; on the opposite it is white clay and sand, and a little higher up on the ridge no clay whatever is found, even to a depth of 200 feet, as was shown where a well was sunk of that depth. In making our observations last Summer in every variety of soil of this region, I have kept a memorandum of each variety examined, and the class of soil wherein it was planted. From your statements I anticipated fully to find the insect, but so far I am safe in saying that your predictions as to our section being infected with the Phylloxera is, happily for us, not fulfilled so far.

Yours truly,
P. J. BERCKMANS.

AUGUSTA, GA., Dec. 10, 1874.

Regarding its introduction into California around Sonoma, Mr. G. L. Wratten wrote, under date of July 9, 1874, that he is quite sure they have it, but that the grape-growers there are quite excited about the matter, and wish to hush the fact.

INJURY DONE DURING THE YEAR IN FRANCE.

So much of the wealth and prosperity of France depends on her grape crop, and the result of the grape harvest is looked forward to with so much anxiety, that the Phylloxera continues to occupy the lively attention of that nation. The investigators have been active and numerous, and each week this little insect occupies no inconsiderable portion of the time of the French Academy. The government has increased the amount of the reward for a simple, available remedy, from sixty thousand to three hundred thousand francs; while several

societies have offered minor sums for the same purpose, and to enable the proper experiments and observations to be carried on.

The decrease which the Phylloxera had caused in the grape product for the past few years has, however, been made up by an excellent average yield in 1874. Notwithstanding injurious late frosts, a severe hail storm and the Phylloxera in some of the southern departments, the yield in the country at large, both in quantity and quality, has been above the average, and her 2,000,000 hectares (nearly five million acres) of vines, giving employment to 7,000,000 laborers, produced, according to the *Economiste Francais,* as much as 70,000,000 hectolitres (over 1,850,000,000 gallons) of wine. Indeed, the vintage was so unusually good in the non-infested districts, that there was an insufficiency of casks; while in some of the ravaged districts it was so poor that the wine makers were glad to sell their casks, for which they had no use, to their more fortunate countrymen.

M. L. Bazille, of Montpellier, in a recent letter says:

> The Phylloxera continues to commit great ravages in our vineyards. We are on the eve of losing them entirely. Those who can submerge do so and with success. They are convinced of its beneficial effects. The efforts and sacrifices made to organize and employ this method attest its value. Several persons have built large engines to elevate the water, and others have been at very large expense to obtain and control water. But it is only the few who can afford such outlays, and the mass of our grape-growers, in view of the poor success attending other remedies, fall back on the use of American vines, through which they hope to be relieved of embarrassment.

SPREAD OF PHYLLOXERA IN EUROPE.

It would be out of place in this report to give a detailed account of the spread of the insect in Europe, and it suffices to say that it continues to widen its territory in France, and that several neighboring European governments have taken stringent measures to prevent the importation of vines from the infested districts of Europe and from America. Just as its presence at Klosterneuburg, near Vienna, Austria, discovered in 1872, was easily traced to American vines which had been introduced there; or as its appearance in Portugal during the same year was referable to the same cause; so at each new point where it has been discovered, its presence has been easily explained, either by gradual spreading from infested districts or by importation on infested vines. Thus its discovery during the year at Pregny, near Geneva, Switzerland, seemed at first to baffle explanation. The fatalists contended that it must have passed from Lyons, France—the nearest infested region—and declared that it was useless to contend against an enemy which could pass over a hundred miles in a season. M. Dumas, perpetual Secretary of the French Academy, conceiving

the importance of having the problem studied and elucidated, commissioned Max. Cornu to make the proper investigations, the result of which was to prove that the only way in which the insect passed the Jura and reached Pregny without leaving its tracks on the way, was by rail, and carefully packed in boxes. In fact it was traced to a grapery belonging to Baron Rothschild, in which were cultivated a number of varieties, and, among others, some obtained from an English grapery, and received as young plants in pots. The insect has for many years existed in graperies in England and Ireland, and the particular vines in question were found to be badly infested. All the infested vines have been condemned to destruction by the Swiss Government.

The insect has, also, recently been found in small quantities on American vines at Bonn, in Prussia, and the German Government has prohibited the importation of American vines.*

DIRECT REMEDIES.

There is little to add to what was said on this subject in my last report. Very elaborate experiments have been carried on in France and as elaborately recorded; yet the fact remains that, as we have already seen, submersion, from the practical standpoint, is the only remedy which is being extensively employed. The use of sand, especially when mixed with cinders and guano is highly spoken of, and the methods of invigorating the vine by fertilizers rich in potassic salts continue to gain in favor. M. Mouillefert, who has experimented at Cognac with sulpho-carbonate of potassium—generating and conveying it in different ways—and M. Balbiani, who has persevered at Montpellier in the use of coal tar, have proved that both these substances may be employed with good effect to destroy the Phylloxera; but it remains to be seen whether their methods will fulfill the requirements by coming into general use. The sulpho-carbonate, which was employed at the suggestion of M. Dumas, is placed at the rate of four ounces in a hole at the foot of a vine. By decomposition the sulphuret of carbon, spoken of last year, is generated and kills the lice without

* Since this was written, I have received the following note from Dr. G. Blankenhorn, of Carlsruhe, referring to the discovery of the insect in other localities:

Your excellent work on the Phylloxera I have copied in my "Annalen der Œnologie," and it has done much to help us in Germany to understand this insect. The subject grows more and more important for us Germans since our viticulture is threatened. You probably have already read that it has been discovered during the last few weeks in three different localities in Germany, (in Annaberg, by Kornike and Kreusler; in Carlsruhe, by myself and D. Moritz, and in Worms), and without exception, only upon American grape-vines."

affecting the vine. The instrument used for introducing the liquids intended to generate the destructive gases, is an augur with a hollow shank, perforated just above the cutting portions. The liquid is poured into the hollow portion of the augur from above the handles.

NATURAL ENEMIES.

It appears pretty certain that the mite I described last year as preying on Phylloxera, is likewise found in Europe; or at least a species that cannot well be distinguished from it. Thus during the year, M. A. Fumouze, an authority on these minute animals, has published some notes showing that he has found this same Tyroglyph on roots affected with Phylloxera in France, and that it is apparently the *T. echinopus* described by himself and Ch. Robin in the *Journal de l' Anatomie et de la Physiologie*, in 1868. Prof. L. Rœsler, of Klosterneuburg, Austria, also announced to me by letter that he has found and studied both the Phylloxera Mite and the Mussel-shaped Mite (*Hoplophora arctata*) on the infested vines of that place. He has also observed, in addition, the larva of a Lace-wing (*Chrysopa*) and the Myriapodous *Pollyxerus cagurus* preying on Phylloxera underground.

In addition to the Weeping Lace-wing mentioned last year, I have this year reared the Consumptive Lace-wing (*Chrysopa tabida* Fitch) from larvæ preying on the gall-lice.

In reference to the heteramorphism of these mites M. Méguin states* that *Hypopus*, *Homopus* and *Trichodactylus* are but heteromorphous pupæ of different species of Sarcoptides, and among them of *Tyroglyphus*. He proves that, as Claparède observed in the aquatic *Atax*, a new individual is formed under each skin, and all the parts are developed anew, and not simply drawn out of their old envelopes, as was formerly supposed.

SUSCEPTIBILITY OF DIFFERENT VARIETIES.

In addition to that already published under this head, I have simply to add that M. Eugene Morel, of Ridgeway, N. C., sent me last August leaves of the Scuppernoug (*Vulpina*) covered with the Phylloxera galls, so that this species can no longer be considered exempt from the attacks of the gall-making type, though the more injurious root-inhabiting type has not yet been found upon it. The "Telegraph" should be taken from the list of Summer grapes (*æstivalis*) and placed with the Northern Fox (*Labrusca*); and the Delaware

* *Comptes Rendus de l' Ac. des Sc.*, Paris June 8, 1878.

should be removed from *Riparia*, also to Labrusca. Though the exact position of the Delaware in the classification of the genus *Vitis* has been a mooted question, and some have even supposed it had a European origin; yet those who have most studied the subject now concur in the opinion, years ago expressed by Fuller in his *Grape Culturist*, that it belongs to *Labrusca*—an opinion substantiated by the facts that its seedlings almost invariably show true, undoubted Labruscan characters, and that other undoubted varieties of Labrusca (as Shepherd's Delaware, raised from seed of Catawba) bear a similar pale fruit and delicate leaf, and otherwise very closely resemble it. The seed characters bear out this opinion, though they also indicate that the variety may contain a slight strain of the European *vinifera*. It is not improbable, therefore, that the Delaware owes its characters to hybridization, by insect agency, between *Labrusca* and *vinifera* (the Labrusca strain predominating), and this view would be greatly strengthened if it could be proved—as was doubtless the case—that European vines were cultivated at Frenchtown, N. J., where Mr. Prevost first found the Delaware. This origin and nature of the Delaware, by the way, throws a flood of light on its susceptibility to Phylloxera.

The nature of the "Jaques," which successfully resists Phylloxera in the vineyards of Mr. Laliman at Bordeaux, in France, and of which I have stated (Fifth Rep. p. 66,) "I do not know this variety unless it be a synonym of the Ohio," has been fully discussed by Prof. Planchon,* and by Mr. Bush in his new Descriptive Catalouge.† I reproduce what is said of it in this last little work, which is a most valuable manual, and reflects great credit on the firm that issues it. From this extract it will be seen that Mr. Bush is strongly inclined to the opinion that the vine so prized in France, under the name of Jacques, is in reality the Lenoir.

OHIO. Syn. SEGAR-BOX, LONGWORTH'S OHIO, BLACK-SPANISH ALABAMA; is now understood to be identical with the "Jaques" or "Jack," introduced and cultivated near Natchez, Mississippi, by an old Spaniard of the name of Jaques. It used to be grown in Ohio, where the stock originated from a few cuttings left in a segar box, by some unknown person, at the residence of Mr. Longworth, of Cincinnati, Ohio. * * *. Downing (Fruit and F. trees of Am.) said "it is most likely a foreign sort, and except in a few localities, a *sandy soil* and a mild climate, it is not likely to succeed." But Geo. W. Campbell, whom we have to thank for valuable information on this and many other varieties, says: "I always considered the Ohio or Segar-Box, from its fruit, habit of growth and foliage, as of the same family as Herbemont, *Lenoir*, Elsinburgh, and that class of small, black, southern grapes." * * *. A few vines sent years ago, under the names of "Jaques" or "Ohio," to France, by P. J. Berckmans, of Georgia, proved very fine and valuable, perfectly resisting Phylloxera, having remained healthy in the midst of vineyards destroyed by the root louse. This attracted great attention

* *Les Vignes Americaines; leur Culture; leur Résistance au Phylloxera*, Paris, 1875.

† Bushberg Illustrated Catalogue, 1875.

and gave importance to this variety. But when Mr. Berckmans was asked for more of these vines, he stated that he had none, and that their culture had been entirely abandoned. The above descriptions by our most experienced and reliable horticulturists, make it more than doubtful whether the vines, succeeding so well in the vineyards of Mr. Borty, at Roquemare, and of Mr. Laliman, near Bordeaux, are the "Ohio" or "Jaques." After considerable research, we find that Mr. G. Onderdonk, the pioneer fruit-grower of Western Texas, describes the *Lenoir* (original stock of which he had obtained from Berckmans) as follows: "*Bunches* large, long, loose; *berries* small, black, round; no pulp; vinous and much coloring matter; leaves lobed; a fine bearer and wine grape. And we would add that the leaf and habit exactly resemble those of the *Black Spanish*. We have never planted a variety that grew off better than this variety has done during the two years we have had it in cultivation. In 1873 we gathered fruit from this variety that had been ripe seventy days on the vine." From these facts we strongly incline to believe that *this Lenoir* is the variety our friends in France are looking for, and have received under the name of Jaques.

GRAFTING AS A MEANS OF COUNTERACTING THE WORK OF PHYLLOXERA.

The advantages of grafting are two well recognized to need enforcing. By its means, healthy, vigorous vines, which do not fruit well, may soon be made abundant bearers; new varieties and seedlings be quickly tested, and a less desirable variety replaced by one more desirable. Our knowledge of the Grape Phylloxera has of late pointed out other cogent advantages that may be derived from grafting, and it is in view of the renewed interest which I have found manifested in it among grape growers, that I venture a few remarks on a subject with which I have had little personal experience, but to which I have given some attention through observation and study of the experience of others.

Having shown that certain varieties of our grape vines have a far greater power of resisting the Phylloxera than have others, and that they represent all degrees of susceptibility, from those which invariably succumb in the course of two or three years, to those which are seldom affected, and never materially; I took occasion to urge judicious grafting as one of the most available means of coping with the disease; and also to request of those grape-growers who have the advancement of their calling at heart, and who are so circumstanced that they can make the trials, to institute experiments in grafting some of the most susceptible varieties. (See Rep. 6, pp 49, and 78–81.) As the report mentioned was not distributed till it was too late in the year for my request to be complied with, and as only the few of whom I made the request, through other means, have begun to carry out the suggestion, I take this opportunity of renewing it, and of offering a few remarks for guidance.

One important fact should always be borne in mind in this connection, and that is, that the Grape vine, having a very thin inner bark or liber, does not graft with the same ease as do the more common of our fruit trees, such as apple, pear, etc.: more care is, therefore, necessary in the operation.

Cleft grafting is the more ordinary mode employed, and it is usually done by digging away the earth, and inserting the graft very early in the Spring, two or three inches, or at the first smooth place below the surface. A horizontal cut of the stock is generally made, but a sloping one is, perhaps, preferable, from the fact that it enables all the gummy matter and excessive moisture which oozes from the cut, to run down, and not accumulate to the injury of the cion. Fuller recommends grafting in the Fall, and while this method is not deemed so advisable in Missouri, where there is such continued alternation of freezing and thawing, which is apt to lift the cion and separate it from the stock; yet I give his method in his own words, as recently published in the New York *Tribune:*

Select cions of the present year's growth, and from canes a quarter to three-eighths of an inch in diameter, and cut into lengths of three inches, with a bud near the upper end. The lower end should be made into a long, slender wedge. Remove the earth about the stock four to six inches, if the main branching roots will permit of this depth. Then cut off the vine a few inches below the surface and square across; then split it with a chisel or knife, making as smooth a cleft as possible for the reception of the wedge-shaped cion. If the stock is an inch or more in diameter, two cions may be needed, one on each side of the cleft.

The outer edge of the wood of the cion should be placed even with the outer edge of the wood of the stock, no attention being paid to the uniting of the two, because one will be very thick and the other thin. A nice fit of the two is essential, and in crooked-grained, gnarly stocks, a smooth, even cleft can only be made by cutting out the wood with a sharp instrument. But it does not matter how it is done if it is well done. After fitting the cions to stock, wind a strong cord about the two, in order to hold the former firm in place; then pack grafting clay or common soil about the stock, entirely covering the wound made and the lower half of the cion, but leaving the bud uncovered. No grafting wax should be employed in grafting grape vines. After the cions have been inserted as directed, invert a flower-pot or small box over the cion; upon this place a quantity of leaves, straw or hay; then cover all with earth, rounding it up in order to keep the water from settling around the grafted stock as well as to prevent too severe freezing.

Early in Spring remove the covering, and if the operation has been properly performed, the cion will be firmly united, and will push into growth as the season advances. I have had Delaware, Iona and similar varieties make a growth of from forty to sixty feet of vine from a single bud in one season, set in strong stocks in the manner described. Grafting in the Spring may be performed in the same manner, omitting the covering, but it should be done very early or after the leaves have started and growth begun. The cions, however, should be cut early and kept dormant in some cool place until wanted for use.

But valuable above all other experience for our own people, will be that of Mr. George Husmann, and as he has said little on the subject in his well known work, "Grapes and Wine," I take pleasure in giving that experience, as he has kindly communicated it to me:

DEAR SIR: As you wished to have my views of grafting the vine, especially with the object of grafting some of our varieties most subject to the ravages of the Phylloxera upon roots of varieties which resist it, I will cheerfully add my mite to the researches which have already thrown so much light upon the history and the failure of so many of our otherwise most valuable varieties. My first attempt at grafting the vine were made in the Spring of 1852, nearly twenty-three years since, and were made by grafting the then rare varieties of Norton's Virginia and Herbemont upon five years old Isabella roots. I found in the first edition of A. J. Downing's "Fruits and Fruit Trees of America," a few remarks on the practicability of grafting the grape below the ground, which led me, then a novice in horticulture, to try it, and with eminent suc-

cess. I took the ground away from the crown of the vine until I came to a smooth place, then cut off the stock, split it with a grafting chisel and inserted from one to two cions, according to size of stock, cut to a long wedge with shoulders on each side. I used no bandages, as the stocks were strong enough to hold the cions firmly, and only pressed moist earth on the cut to cover the wound. This was done on the 22d and 23d of March, and the cion covered and shaded to the top bud. About three-fourths of the grafts grew vigorously and fruited the next year. They have produced heavy crops ever since, and when at Hermann, a week ago, I still found them vigorous and healthy, while the Catawbas around them have "passed away" several years ago. I have practiced various methods since, with more or less success, and still think this the best and most practicable, though it is neither an easy nor a pleasant task, as it must be performed when the ground is still cold and moist, and requires a good deal of stooping. The inner bark or liber of the vine is very thin, while the outer bark is very thick on a large old stock. The success of the operation depends entirely on a good junction of the liber of stock and cion, and therefore requires a steady hand and a good eye to push the cion to its place. My friends, the venerable Fr. Muench and Samuel Miller, practice about the same method, and are both almost invariably successful. The cions should, if possible, be cut in Fall and kept on the north side of a building or fence, so as to remain dormant. Should the stock not be strong enough to hold the cion firmly, it should be tied with basswood bark, or an oblique cut be made instead of a split. This is preferable in small vines any way, as by so doing, the fibres of stock and cions are both cut obliquely, and therefore make a closer fit.

There are other different methods. Another, which I will mention here, has been practiced at Hermann with very good success, though I have not been very successful with it. It has the advantage of saving the vine, provided the graft does not take. It is done by simply making an oblique cut into the stock below the surface or crown, and inserting the cion, cut to a rather blunt wedge, by bending the stock to one side, and thereby opening the cut. If the cion takes, the stock is cut off above it. Another method is grafting under the bark later in the season, when the sap flows freely and the bark peels readily; a long, slanting cut is made on one side of the cion, the stock cut off square, the bark lifted with a knife, and the cion pushed down under it. Every one who has practiced budding will readily perform this operation. The stock is then tied with basswood bark. I have followed this plan with varied success later in the season, but prefer the first method. I think grafting above ground impracticable in our climate, on account of the high winds and drying influence of our Summer sun.

As to the advantages to be gained by grafting, they are manifold. They may be summed up as follows:

1. The facility it gives us to try and fruit new and rare kinds by grafting them on strong stocks of healthy varieties, where they will often make wood strong enough for fruiting the next season, and give us abundance of propagating wood, thus gaining more than a year.

2. Nearly every vineyard contains some worthless varieties, which are, however, strong and healthy growers. These can, by grafting, be changed into the most valuable varieties.

3. The facility by which varieties which are very difficult to propagate may be increased and multiplied, as nearly every variety will graft readily.

4. Last, but not least, it gives us a means of successfully combating the Phylloxera, as your experiments have so conclusively proven. If the Catawba and many of our other most valuable varieties, have deteriorated because this little insect has been to work on their roots, and the roots of other varieties are comparatively exempt from its ravages, the remedy would indeed be a very simple one. By planting such varieties as propagate readily, and also graft with ease, they could be changed by grafting the second Spring. I know, from experience, that slow growing varieties can be made to grow much more vigorously by grafting on stocks of strong and healthy growers. The most vigorous and productive Delaware I know around Hermann, was grafted on a Norton's Virginia, and produced an abundance of fine fruit, when Delawares on their own roots, in the same vineyard, dropped their leaves, and did not ripen their fruit. It is certainly of the utmost importance that experiments of this kind should be made, and I would advise all lovers of the Catawba and Delaware to try it.

But now the question arises, what stock shall we choose? The Clinton, though easy of growth, is a poor stock, as it suckers inveterately, and, besides, has not the affinity to most of our valuable varieties which makes them take readily on it. In fact, I do not consider any of the Riparia or Cordifolia class as good stocks, for Labrusca and its hybrids, or Æstivalis. But the Concord seems to me eminently the stock to graft upon. Easy of propagation, within the reach of every one, with the adaptability to any soil it possesses, and as nearly every variety will unite readily with it, it seems as if hardly a better one could be found. But were I to plant it for this purpose, I would take good, strong plants, say at least one foot long from the cutting to the

crown, plant them with their roots one foot below the surface, and trim off the surface roots clean, only leaving the roots on the two lower joints. Then cultivate well for one year, and graft as near the surface as practicable to insure the life of the cion. Should the plants make roots above the junction, I would cut them smoothly close to the graft every Spring, and thus establish the plant entirely upon Concord roots.

This may seem very troublesome to our friends who plant vineyards entirely upon the easy plan, and let them take care of themselves. But I think that their days are numbered. This slovenly culture, or rather no culture at all, will never make us a wine producing country worthy of the name; and if we had not a single one of that stamp left among us, I believe we would be infinitely better off than we are now. If France can import millions over millions of our American varieties to regenerate her devastated vineyards, we can certainly afford to use the means ready at hand. Our American wines have a glorious future, and we have the material for the grandest results already. Last August I sent two boxes of assorted wines, fifteen varieties, made by Messrs. Poeschel & Scherer, at Hermann, to my French correspondent, Messrs. Douysset Fils, at Montpellier. I quote from a letter just received, the following: "We have duly received the wines of Mr. Husmann, and they were exhibited by us before the International Congress of Viticulture, just held at Montpellier, and tested by a committee of thirty members, officially appointed for that purpose. They were about the best connoisseurs of France. Norton's Virginia and Cynthiana, as red wines, Martha, Gœthe, and above all, Hermann and Rulander, as white wines, were highly praised; and the general opinion is, that after we have restocked our vineyards with American vines, we will not regret the loss of our own very much. As to Concord, Ives, Wilder, North Carolina, Clinton, Herbemont and Cunningham, they will very likely be generally planted in our black soils, and much used for stocks for our Aramons."

This was accompanied by an order for a million of Concord and all the Herbemont cuttings I could yet secure, as well as smaller orders for other varieties. When our products are thus appreciated in the greatest wine producing country we should throw sloth and sluggishness aside and go to work in good earnest and with all available means. Let none follow or commence grape growing in the future who are not willing to do their best. We want brains and skill, as well as muscle. We want close observation, indefatigable exertion and intelligent labor in the vineyard as well as in the wine cellar. It is my belief that the darkest days of American grape culture are over, and that the future will not fail to bring us glorious results if we labor for it faithfully.

Your labors have done a great deal to post us in regard to our insect enemies and friends, and should be gratefully appreciated by every grape grower, while all should do their part in sending you specimens and observing their habits.

GEO. HUSMANN.

SEDALIA, MO., December 20, 1874.

It will be noticed that the above experience and directions refer solely to grafting underground. Both Fuller and Husmann deem grafting above ground impracticable in our climate, principally on account of our winds; and their advice has been so very generally followed that little attention has been given to this mode of grafting the grape vine. The consequence is that we have the most conflicting experience as to the results of grafting; for, by the underground methods, the graft will make its own roots in the course of a few years, unless very great pains are taken to prevent such an occurrence; that it has done so in the majority of cases of grafting in this country in the past, admits, I think, of little doubt. Yet, in grafting as a means of counteracting the Phylloxera, the first requisite is to prevent the graft from making any roots of its own; for it must be remembered that we are dealing with a root malady purely, and that the object is to grow those varieties whose roots succumb more or less to the attacks of the insect, by using the roots of those which resist;

this object is necessarily frustrated in proportion as the graft forms roots of its own.

There are two methods of grafting above ground, which I have every reason to believe may be made more successful than grape growers have hitherto been led to suppose. The first is by temporarily making a false surface and grafting in the ordinary manner just described, *i. e.*, instead of digging away the earth and inserting the cion two or three inches below ground, it should be inserted two or three inches above ground and the earth thrown up around it, to be removed only after the graft is thoroughly and permanently joined. There will then be no danger of the graft forming its own roots; and it is certainly as easy to throw the earth around the vine as to dig it away, while the mechanical work can be much more conveniently and agreeably performed above than beneath the surface. No doubt this mode of grafting needs greater care to make it successful, especially in a very dry season, as the mound is more apt to dry out than the level ground. Yet there is not lacking evidence that this method will work well in our soil and climate. Mr. Jno. Vallet, of New Haven, a grape-grower of much experience, has had eminent success in thus grafting above ground, employing flax twine and paw-paw bark for bandaging. He considers that the vine grows more vigorously and that there is less danger of separating the graft when once formed, as there is no necessity for going below ground to destroy the suckers, the doing of which sometimes loosens the graft.*

The second method is by inarching. This system of grafting does not seem to have been much practiced in this country, yet while it requires great care, and success may not as often crown the effort as in the former methods, I hope more attention will in future be given to it.

The operation is comparatively simple: A slice two or three inches long is cut from one side of the vine to be grafted, and a similar slice from the vine which is to serve as stock, as near the base or butt as possible. The two cut portions are then brought face to face, so as to fit as neatly as possible, and are then bound together with cord, basswood bark or other grafting bandage, which should be kept

* Mr. Vallet informs me that in 1861 he grafted above ground for Emile Mallinckrodt, in St. Louis county, a number of Catawbas on Isabella stock; that they did admirably, and subsequently produced from 60 to 80 bunches to each vine. He also, in the same manner, in the years 1862 and 1863, grafted Delaware onto Isabella, 12 miles from St. Louis in Mr. Layton's vineyard on the Olive street plank road. The grafts did splendidly, and subsequently gave fine crops. By contrast to this experience, and interesting from the Phylloxera standpoint, he grafted for Miller & Bates, of New Haven, Virginia Seedling on Catawba, (1500 in 1866 and 1500 in 1867,) and no grapes resulted, only five per cent. of the grafts growing.

moist with moss. In the course of a fortnight partial unison takes place, when the bandage should be somewhat loosened to admit the expansion. In six or eight weeks, if the operation is successful, the stock and cion are firmly united, when the bandage may be removed. The graft immediately below the union and the stock immediately above it should then be partially severed, and in a week or so more, entirely cut loose.

While, as already stated, this mode has not been much practiced in America, sufficiently successful results have been obtained to encourage further trial; and, as an example, I will mention one instructive instance communicated by my friend Isidor Bush. One of his customers, Eugene Cambre, of Nauvoo, Ills., has for some time furnished him with a superior quality of Delaware wine; and being anxious to know how Mr. Cambre succeeded so well with the Delaware, when so many others in the same neighborhood failed with it, Mr. Bush inquired as to the reason, and found that it was Mr. Cambre's custom in planting a Delaware vineyard to plant alternately with a Delaware, a wild vine from the woods, and to subsequently transfer the Delaware onto the roots of the wildling, by this system of inarching.

The Delaware, as may be seen by the tabular statement in my last report, is among those which suffer materially from the Phylloxera, and several other cases of its successful growth when grafted onto wild vines, where on its own roots it failed, were elicited at the recent meeting of the Illinois State Horticultural Society, held at Peoria.

Mr. Cambre has very kindly communicated to me his method, but the following description of it, from the Grape Manual of Messrs. Bush & Son & Meissner, so well covers the ground that I give it in full:

For this method it is desirable that two plants, one each of the variety which is to form the stock, and one of the scion, be planted close together, say about one foot apart. In June, (the first year, if the plants make a sufficiently strong growth, if not, the second year,) or as soon as the young shoots become sufficiently hard and woody to bear the knife, a shoot is taken from both the stock and the scion vine, and at a convenient place, where they may be brought in contact, a shaving is taken out from each of these, on the side next to the other, for a length of 2 to 3 inches. This must be done with a smooth cut of a sharp knife, a little deeper than the inner bark, so as to obtain on each a flat surface. They are then fitted snugly together, so that the inner bark joins as much as possible, and wrapped securely with some old calico torn in strips, or soft bass strings. Besides this, it is well to place one tie a little below, and one above the grafted point, and also to tie the united canes to a stake or trellis to insure against all chances of loosening by the swaying of the wind. The rapid swelling of the young growth at this period of the year makes it desirable that the grafts be looked over after a few weeks, replacing such ties which may have burst, and loosening others which may bind so as to cut into the wood. A union will generally be made in the course of two or three weeks, which will be further consolidated in the course of 6 to 8 weeks, when the bandages may be removed and the grafted portion left exposed to the sun, to

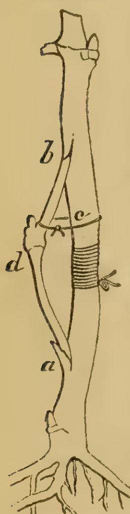
thoroughly harden and ripen it. The shoots themselves are to be left to grow undisturbed for the rest of the season. In the Fall, if a good union has taken place, the cane forming the scion is cut close *below* its union with the stock cane, which in its turn is cut close *above* the connnection. Supposing the stock to have been a Concord and the scion a Delaware, we now have a vine of the latter entirely on the strong, vigorous root of the former. Of course constant vigilance must be exercised to prevent suckers from starting out of the stock. It is well to protect the grafted joint the first few winters by a slight covering of straw or soil to prevent the frost from splitting it apart.

Mr. Cambre in giving his experience writes: "I have positively abandoned cleft grafting; it is too much trouble and too uncertain, and the graft often makes its own roots. I assure you that from a long experience in inarching, I am of the opinion that not alone the Delaware but most of our cultivated varieties will do better on native wild roots than on their own. I have 14 acres of vines mostly grafted in this manner on wild stocks, and I have not lost one of such grafts. It is preferable to graft at from 10 to 15 inches from the ground."

Another mode of grafting above ground is thus given in "The Cultivation of the Grape," by W. C. Strong:

In *The Gardeners' Monthly*, Vol. II, p. 347, is a description of a mode practised with success by Mr. Cornelius, which we copy, not merely as it is interesting in itself, but also because it illustrates many other modifications in grafting:

[Fig. 20.]



"After the first four or five leaves are formed, and the sap is flowing, you choose the place on the vine where you intend to graft. At that point wrap tightly a twine several times around the vine. This will, in a measure, prevent the return sap.

"Below the ligature make a sloping cut down, as shown at Figure 20, *a*; also, a similar reversed one above the ligature, as at *b*, about one inch in length. In selecting a scion prefer one that has naturally a bend. Cut it so that it shall be wedge shaped at both ends, and a little longer than the distance between the cuts in the vine at *a* and *b*. Insert the scion, taking care to have the barks in direct contact, securing it with a string, *c*, bound round both scion and vine sufficiently tight to force the scion ends into their places. If the work is done well, no tie will be required at *a* and *b*, but the joints should be covered with grafting wax. In a short time, the bud at *d* will commence its growth, after which you can by degrees remove all the growing shoots not belonging to the scion, and in course of the Summer you may cut off the wood above *b*, and in the Fall remove all above *a* on the stock, and above *c* on the scion.

Still another mode of grafting which has, I believe, seldom, if ever, been attempted in this part of the country, but which has been employed with much satisfaction the past year by a few vine growers in France, and especially by M. H. Bouschet, of Montpellier, remains to be mentioned. It is the Winter grafting of a cutting of such variety as is desired to grow, upon another which is to be used as stock, the combined cuttings being planted in the usual manner in Spring, leaving only the buds on the graft proper out of ground. This is very similar to our ordinary mode of making apple grafts; and while we have little or no experience in this country on which to base anticipations, the method is worthy of trial, and is illustrated at figure 21.

[Fig. 21.]

But not to weary with details, I here reaffirm my belief, strengthened by each further observation, and by every additional experience of the past year, that just as the working of the root-louse is the primal cause of failure of some of our choicest varieties of the Grape vine, so in judicious grafting we have the most available means of counteracting its work, and of thus growing successfully many of those kinds which cannot be grown in this latitude with any profit or success on their own roots.

The recommendation to use our most resistant varieties as stocks for the French vines in the districts ravaged by the Phylloxera have already been followed by large demands for such varieties by the people of those districts, and while we yet scarcely know how our vines will act under the new conditions in which they are placed, the uncertainty as to the results of judicious grafting here at home, scarcely presents itself, for everything augurs favorably.

I have not, in the foregoing paper, entered into the discussion of the special influence of the graft on the character of the root, and *vice versa;* because I believe that, while the one doubtless does manifest a certain special influence on the other; yet, for practical purposes, we know that it is so slight as hardly to be worth considering in this connection. The influences of the one on the other are almost entirely due to the abundance or lack of nutrition in the root, and present in the graft no other changes than those of greater or less development in the different parts of its growth; and not in the specific character or quality of the fruit. Geo. Gallesio, in his work on the Orange Family, in which he fully considers the influence of grafting, lays stress on these facts.

In conclusion, I again appeal to those of my grape-growing readers who have the opportunity, to make experiments in grafting the more susceptible on to the roots of the more resistant varieties, and, as a guide, I repeat the following list of varieties that it is desirous to test as stocks and as grafts:

ROOTS TO USE AS STOCK.

1. Concord.	5. Norton's Virginia.
2. Clinton.	6. Rentz.
3. Herbemont.	7. Cynthiana.
4. Cunningham.	8. Taylor.

VARIETIES TO GRAFT ON TO ANY OR ALL OF THE ABOVE.

Of First Importance.

1. Catawba.
2. Iona.
3. Delaware.
4. Wilder.
5. Goethe.
6. Any European vine.

Of Secondary Importance.

7. Ives.
8. Hartford Prolific.
9. Maxatawney.

This list is given wholly from the Phylloxera standpoint, and with a view to discover the real influence of the resisting on the nonresisting kinds. There are many grape-growers who will agree with Mr Husmann, who has so high an opinion of the Cynthiana, that to graft even the Catawba upon it would, as he has remarked to me, "appear like sacrilege." Others again will not think the Hartford and Ives, for instance, worth saving, since they do not deem them worth planting. But any of the experiments indicated—no matter what the quality of the fruit—will prove valuable as showing the influence of a root that is proof against Phylloxera on a vine which on its own roots suffers from it. Experience is not wanting to show that several of the susceptible *Labruscas*, and many hybrids with *vinifera* grow with excellent success on the vigorous roots of *æstivalis;* but let us increase the experience on this point in every direction possible. If the reader can make but one or two of these experiments, I shall consider it a favor to have him do so, and inform me precisely as to the number and varieties grafted, the method employed, the character of the soil and all other details of interest. My object is to have these experiments made on different soils and in different latitudes; and, in the course of two or three years, I hope to gather the results from all quarters, and we may thus be enabled to draw conclusions of much importance to grape-growers.

AMERICAN GRAPE-VINES ABROAD.

Having already referred (pp. 104, 114) to the large demand that has been made for some of our American vines to be used as stocks in the blighted districts of France,* it is only necessary to add that experience over there with such vines is by no means discouraging; and that it is not at all improbable that some of our varieties will be eventually grown there not only as stocks for the European *vinifera* but for their own grapes, just as they are to-day, on account of greater hardiness and vigor, superceding the European vines in some parts of Australia,

* Mr. Husmann estimates in the *Rural World* for January 9, 1875, that the importation of American cuttings into France, during the Winter of 1874–5 will amount to ten millions.

Of the varieties which have thus far given most satisfaction, may be mentioned the Herbemont, Cunningham, Clinton, Concord, and especially the variety called Jaques, and which, as we have already seen, is probably Lenoir.

APPENDIX.

SYNOPSIS OF THE AMERICAN SPECIES OF THE GENUS *PHYLLOXERA*, Fonscolombe.

[On account of the interest attaching to the Grape Phylloxera, or, as it is now very generally called, THE Phylloxera, I have prepared the following Synopsis of the N. A. species of the genus, and give it as it at first appeared in the *Comptes Rendus* of the Paris Academy of Science for December 14, 1874.]

1. P. VASTATRIX Planchon. *Pemphigus vitifoliæ* Fitch. *Peritymbia vitisana* Westwood. Forming galls on the leaves, and swellings on the roots of *Vitis*. Introduced into Europe and well known as the Grape Phylloxera.
2. P. RILEYI Lichtn. Mo. Ent. Rep. V, p. 66, note; ibid. VI, pp. 64 and 86. Living on the underside of the leaves, and hibernating on the stems of *Quercus alba*, *obtusiloba* and *bicolor*.
3. P. CARYÆFOLIÆ Fitch. N. Y. Ent. Rep. III, ½ 166. Forming conical galls, which open at the summit, on the upper side of the leaves of *Carya alba*.
4. P. CARYÆCAULIS (Fitch) *Pemphigus caryæcaulis* Fitch, ibid. ½ 163. *Daktylosphæra subellipticum* Shimer, Trans. Am. Ent. Soc. II, p. 389. *Dak. caryæ-magnum* Shimer, ibid. p. 391. Forming elongate, rather irregular, but generally ellipsoid smooth, green swellings of large size, on the petiole of the leaf of *Carya glabra* and *amara*; the gall subsequently cracking open and becoming black and contracted.
5. P. CARYÆVENÆ (Fitch). *Pemphigus ? caryævenæ* Fitch. N. Y. Ent. Rep. III, ½ 164. Forming plaits in the veins of the leaves of *Carya alba*, which plaits project up from the surface in an abruptly elevated keel upon the upper surface of the leaf, and with a mouth opening on the underside, the lips of which are wooly.
6. P. CARYÆ-SEMEN (Walsh). *Xerophylla caryæ-semen* Walsh. Proc. Ent. Soc. Phil., VI, p. 283. *Daktylosphæra caryæ-semen* Walsh, 1st Ann. Rep. as acting State Entomologist of Illinois, p. 23, note 1. *Dak. globosum* Shimer, Trans. Am. Ent. Soc., II, p. 391. Forming fuscous, minute, subglobular, seed-like galls on leaves of *Carya glabra*, the galls opening in a small nipple on the underside.
7. P. CARYÆ-GLOBULI Walsh, Proc. Ent. Soc. Phil. I, p. 309. *Daktylosphæra hemisphericum* Shimer, Trans. Am. Ent. Soc. II, p. 387. Forming hemispherical galls about 0 25 inch diameter on the upper surface of the leaves of *Carya glabra* and *alba*, the galls rather flat below, where they open in a slit.

8. P. SPINOSA (Shimer). *Dak. spinosum* Shimer, Trans. Am. Ent. Soc. II, p. 397. Forming large, irregular galls, covered with spines, on the petiole of the leaf of *Carya amara*, the galls opening beneath in an irregular, sinuate slit.

*9. P. CARYÆ-SEPTA (Shimer). *Dak. caryæ-septum*, ibid. p. 389. Forming flattened galls with a septum on the leaves of *Carya alba*, the galls opening both above and below. Probably only an abnormal form of No. 7.

10. P. FORCATA (Shimer). *Dak. forcatum* Shimer, ibid., p. 393. Forming galls much like those of No. 6, but larger.

11. P. DEPRESSA (Shimer). *Dak. depressum* Shimer, ibid., p. 390. Forming depressed galls on leaves of *Carya alba,* the gall opening below with a constricted mouth fringed with filaments. *Dak. coniferum* Shimer is, in all probability, the same.

*12. P. CONICA (Shimer). *Dak. conicum* Shimer, ibid., p. 390. Forming galls similar to No. 11, but without the fringe. Probably the same.

*13. P. CASTANEÆ (Haldeman). Fitch N. Y. Ent. Rep. III, § 200. Referred to *Chermes* by Haldeman, but undoubtedly a *Phylloxera*.

Those with a star (*) I am not personally familiar with, but I have no doubt they are good species. The others I am well acquainted with. We have also some undescribed species, the three following of which are so characteristic that I will briefly describe their galls:

14. P. CARYÆ-GUMMOSA N. sp. Forming pedunculated, ovoid or globular galls on underside of *Carya alba;* the gall white, pubescent, and gummy or sticky, opening below in a fibrous point. The eggs are almost spherical, pale and translucent. Larva, mother-louse and pupa quite pale, the red eyes and eyelets strongly contrasting. The winged insects with difficulty distinguished from some of the other species, a difficulty made all the greater from the fact that other species get caught in the sticky surface of the gall.

15. P. CARYÆ-REN N. sp. Forming numerous, more or less confluent, mostly reniform galls on the petiole and leaf stems of *Carya glabra;* the galls varying from 0.2 to 0.7 inch in diameter, pale green and densely pubescent, and opening in a slit the whole of their length, transversely with the axis of the petiole.

16. P. CARYÆ-FALLAX N. sp. Forming conical galls thickly crowded on the upper surface of the leaves of the *Carya alba*. Strongly resembling No. 3 (*caryæ-foliæ*) but the hight one-third greater than the basal diameter, and opening below, instead of above, in a circular fuzzy mouth. This is the species briefly referred to under the same name by Walsh, First Ann. Rep. etc., p. 23, note.

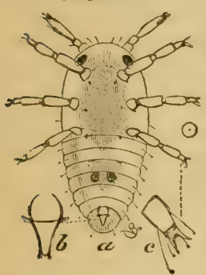
Thus we have at least sixteen good, undoubted species inhabiting the United States. Most of them are more easily distinguished, as is often the case with *Cynipidæ* in Hymenoptera, and *Cecidomyidæ*, in Diptera, by their habits and the peculiar galls they form, than by colorational or structural differences. In fact all the species, except, perhaps, Nos. 1 and 2, yet need more careful and discriminating study and descriptions, in all stages from the living material.

THE AMERICAN OAK PHYLLOXERA—*Phylloxera Rileyi* Lichtn.

Through the kind assistance of Miss Mary E. Murtfeldt, who, at my request, watched this species most closely and assiduously from its awakening to activity in the Spring till its dormancy in the Fall, and was thus enabled to supplement my own observations which were unavoidably interrupted by other duties, I have been able to add many positive facts to what was previously known of its natural history—facts which are interesting and valuable in this connection as throwing light on the natural history

of the congeneric Grape species. Undergoing all its changes above ground, the evolution of the Oak Phylloxera is much more easily studied than is that of the Grape Phylloxera; and I have had better fortune in obtaining the sexual individuals from the winged females, though the few specimens mounted so as to be of any value for description, are all males. These beings are so excessively minute that their study is attended with many difficulties, unless one can devote more time to it than has been at my disposal; yet, with the exception of the description of the true female, its natural history may now be considered complete; while the thorough observations of Balbiani on the closely allied European *Phylloxera quercus** Fonsc., will supply inferentially the missing data. We saw last year that the American Oak Phylloxera hibernates in the larva state attached to the twigs. "As the leaves begin to put forth, our young Oak Phylloxera cast off their Winter skin, and their lethargy with it. They may then be seen crawling up and down the twigs, but do not settle on the leaves. Attaining, in a few days, full growth, they begin a virginal reproduction by covering the twigs with eggs, which hatch in just about a week if the weather is warm and propitious. Thus the hibernating lice acquire their growth, and give birth to the first generation, in the short space intervening between the opening of the buds and the full growth of the first leaves."—[6th Report, p. 65. This first generation, which is sufficiently numerous, as the hibernating mothers are very prolific, disperses over the leaves, and one generation of parthenogenetic wingless females, follows another till the fifth or sixth, when, from the middle to the end of July, the winged females begin to appear. There is the same diminution in fecundity, until the appearance of the winged individuals that has been observed by Balbiani in the European *quercus;* and the winged females, just as in the other species, bear only a few eggs of two sizes, which give birth to the sexual individuals. These pair and the female lays the solitary egg, which gives birth to the normal parthenogenetic mother, which hibernates as a larva. The variation to which the species is subject; or rather the different forms which it presents, will be appreciated by the scientific reader from the following specific diagnosis:

[Fig. 22.]



Male Phylloxera Rileyi, showing genital organ (*b*) and tarsus (*c*); the dot at side showing natural size.

SPECIFIC DIAGNOSIS OF PHYLLOXERA RILEYI Lichtn.

Apterous, agamous ♀; normal form (*a*):—

Length, 0.016 inch, or rather more than 1-3 as large as *vastatrix*, with which it agrees in color. Proportionally more slender, with the abdomen more tapering. Body insected and covered with tubercles very much as in wingless *radicicola* form of *vastatrix*, but with an additional pair on the head, and those on the seventh abdominal joint always distinct. These tubercles concolorous with the body, fleshy, more or less elongate—from 1-12—1-6 the width of middle body—and surmounted at tip with a short, dark hair. The anterior tubercles longest; the lateral outline showing a series of thirty-six such tubercles, nearly equidistant, springing at about right angles from surface. The intermediate dark points, on thoracic insections, also as in *vastatrix*. Antennæ precisely as in *vastatrix*. Legs with the ends of tibiæ more swollen, and the claws more prominent. Venter, with a dusty tubercle just inside each coxa.

* There is some confusion as to what should really be considered the *quercus* of Fonscolombe, and Signoret, Balbiani and Lichtenstein have each in turn recently endeavored to define the European species. Signoret would reduce them all to three (*Comptes Rendus*, Dec. 7, 1874), as follows: 1. *Ph. quercus* Fonsc.=*Balbianii* Lichtn.=*coccinea* Balb. 2. *Ph. coccinea* Kalt.=*quercus* (Sign.)=*coccinea* Hayden. 3. *Ph. corticalis* Kalt.=*Lichtensteinii* Balb.=*Rileyi* Lichtn. Lichtenstein, on the contrary, makes four species (*ibid*, Feb. 8, 1875), as follows: 1. *Ph. quercus* Fonsc.=*coccinea* Hayden. 2. *Ph. Rileyi* Lichtn.=*corticalis* Kollar.=*Lichtensteinii* Balb. 3. *Ph. Balbianii* Licht. 4. *Ph. acanthochermes* Kollar.=*scutifera* Sign. In either event the genus is much more poorly represented there than in America. I would remark here also that I very much doubt whether our American Oak species occurs in Europe, however closely the *corticalis*, which differs in habit, may resemble it in appearance.

Deep yellow Form, with longer, roughened Tubercles (*b*) :—

As frequent as *a* in July, and differing in the deeper color, inclining to brown, and in the greater length, irregularity, and darker color of tubercles : these tubercles are generally longest on middle body, and appear quite dark under a pocket lense ; under the microscope they appear quite roughened with fleshy points from the sides toward the swollen base, and around the somewhat blunt, and sometimes slightly swollen tip.

Black Form, with very long Tubercles (*c*) :—

With the body dark brown and the tubercles almost black; the dorsal ones, especially in middle of body, very long—half the diameter of body—slender, gradually tapering to tip, the lateral ones and some of the dorsal ones, less tapering and half as long. Antennæ with the third joint quite long and slender.

Pupa, normal Form (*d*) :—

With the tubercles prominent, and the pale, mesothoracic portion occupying more of the body than in *vastatrix*.

Smooth Form (*e*) :—

More elongate, paler, without tubercles. Only occasionally met with.

Winged agamous ♀ (*f*) :—

With the dark, mesothoracic band much as in *vastatrix;* the wings more slender, and somewhat more fuliginous, with the costal angle more produced and blunt, and the hook larger on secondaries; the antennæ with the third joint and the horny parts proportionally longer. Also presenting two forms of body and wings as in *vastatrix*.

Male (*g*) :—

Not much larger than the newly-hatched larva; without tubercles, having but a few faint, hair-like points in their stead: the two tarsal claws distinct, but the basal joint of tarsus obsolete: the antennæ simple (at least there is, if anything, but the faintest trace of a small plate at tip) : no sign of mouth-parts; the venter sometimes shows two opaque spots about middle, and the penis is quite conspicuous, the external parts seeming to consist of a tubercle which is bulbous at base, but pointed at tip, and of two dusky, apparently horny processes which run down each side as if to protect it.*

(The eight specimens obtained from winged ♀, which I have mounted, all seem to be of one sex, unfortunately, and no ♀ is among them.)

Newly-hatched Larva (*h*) :—

Nearly smooth, with dark limbs and eyes, the tubercles indicated by slight swellings, which are, however, surmounted with a longer fleshy hair. The proboscis reaching beyond tip of abdomen.

Hibernating Larva (*i*) :—

With the tubercles quite large, smooth, and surmounted at tip with a single spinous hair.

The true female yet remains to be described. Most entomologists would consider the forms *c* and *e* as specifically distinct from *Rileyi*—so abdormal do they appear : but a careful Summer's study of our Oak Phylloxera leads me to the conclusion that they are but forms of one and the only species occurring on the Oak in America. In fact, the polymorphism of these insects is not yet sufficiently appreciated even among entomologists ; and I am strongly inclined to believe that the discussion about the different species occurring on Oak in Europe, is based, in great part, on the variations of a single species. The tubercles in *Rileyi* vary somewhat with each molt, and I have come to look upon the paleness or intensity of color as of little specific value.

At least five generations intervene from the mothers which hibernate to the winged form appearing first in July ; and, from having enclosed some of the first winged females in muslin bags covering leaves that were carefully freed of all insect life ; and having subsequently found such leaves infested with the ordinary agamous female with her progeny in all stages, there is reason to believe that the winged mothers may

* These males are so very minute, that the generative organ is not easily resolved, and presents a different appearance, according to position on the slide; but in most cases I could discern these dusky processes with sufficient distinctness.

be produced twice a year; *i. e.* there are two full cycles of development annually. It is quite evident to me, however, that there is no great regularity as to the time of the appearance of either the winged or sexual individuals; or even as to the number of generations intervening between two generations of winged mothers: so much depends on conditions, and the species is so easily influenced in its development by the character of the weather and food conditions. Thus, the winged mothers are much more abundant on young trees with tender succulent foliage than on the tougher leaves of the larger trees; and I am pretty confident that it is no particular generation that hibernates; but that it may be either the first, second, third, etc., from the impregnated egg, according as we have early or late cold weather. From August the insects continue to grow and multiply, with decreasing rapidity however, until the leaves commence to turn. The mothers then gradually perish and the young forsake the leaves and crowd around the stems; this happening in 1874, from the middle to the end of October.

Whether with this species, as in the case of the Grape, and the European Oak species, some of the wingless, agamous females also lay the sexual eggs precisely as do the winged females, I have not yet ascertained; though I have no reason to doubt that such will prove to be the case.

THE ROCKY MOUNTAIN LOCUST—*Caloptenus spretus* Thomas.*

(Ord., ORTHOPTERA; Fam., ACRIDIDÆ.†)

This insect is a fit subject for the close of that portion of the present Report which comes under the head of "Noxious Insects." Few, indeed, are there more noxious than this plague of the West, which in 1874 proved a national calamity, reducing untold thousands to misery and distress. Feeling the importance of the subject, I spent some time in the ravaged districts of Kansas, and carefully studied the habits of the pest as it poured into our western counties.

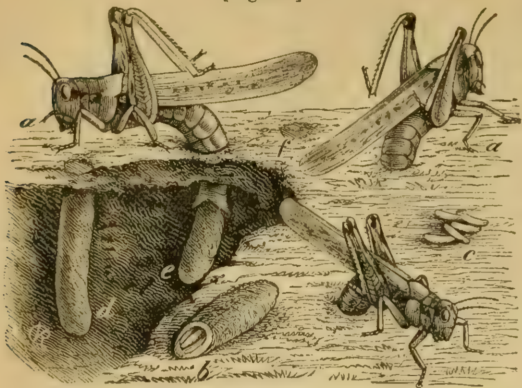
ITS NATURAL HISTORY.

The life-history of this insect is essentially the same as that of the more common locusts that are with us every year. The female, when about to lay her eggs, forces a hole in the ground by means of the two pairs of horny valves which open and shut at the tip of her abdomen, and which, from their peculiar structure, are admirably fitted

* The species was named in MS. by Mr. P. R. Uhler, of Baltimore, Md., but never by him described. Mr. B. D. Walsh subsequently (*Pract. Ent.* II, p. 1) adopted Mr. Uhler's name in connection with a partial description; but Mr. Thomas first fully defined the species, as here distinguished and referred to by me. The question as to the validity of the species will be discussed in the proper place.

† *Locustidæ* of Westwood.

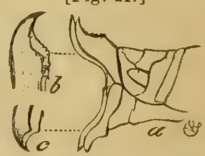
[Fig. 23.]



Rocky Mountain Locust:—*a*, *a*, *a*, female in different positions, ovipositing; *b*, egg-pod extracted from ground, with the end broken open, showing how the eggs are arranged; *c*, a few eggs lying loose on the ground; *d*, *e*, shows the earth partially removed, to illustrate an egg-mass already in place, and one being placed; *f*, shows where such a mass has been covered up.

for the purpose. (See Fig. 24, where *b*, *c* show the structure of one of each of the upper and lower valves). With the valves closed she pushes the tips in the ground, and by a series of muscular efforts and the continued opening and shutting of the valves, she drills a hole until, in a few minutes (the time varying with the nature of the soil) the whole abdomen is buried, the tips reaching an inch or more below the surface, by means of great distention. Now, with hind legs hoisted straight above the back, and the shanks hugging more or less closely the thighs, she commences ovipositing, the eggs being voided in a pale, glistening and glutinous fluid which holds them together and binds them into a long cylindrical pod, covered with particles of earth which adhere to it. When fresh the whole mass is soft and moist, but it soon acquires a firmer consistency. It is often as long as the abdomen, and usually lies in a curved or slanting position. It is never placed much more than an inch below the surface, except where some vegetable root has been followed down and devoured, and the insect leaves her eggs before emerging; in this way the mass is sometimes placed a foot below the surface. The eggs which compose this mass are laid side by side to the number of from 30 to 100, according to size of mass. They are 0.15 to 0.20 inch long, one-fourth as wide, slightly curved, of a pale yellow color, and rather larger at the anterior than the posterior end. As the hatching period approaches, they become more plump and pale, and the embryo, with its dark eyes, is visible through the shell which is now somewhat transparent. The opening to this egg-mass is covered up by the mother, but the newly hatched insect has no difficulty in escaping. When first hatched the little hopper is quite pale, but soon becomes mottled with gray and brown. In escaping from the egg it is at first covered with a delicate

[Fig. 24.]



Rocky Mountain Locust:—Anal characters of female, showing horny valves.

[Fig. 25.]

ROCKY MOUNTAIN LOCUST:—*a*, *a*, newly hatched larvæ; *b*, full grown larva; *c*, pupa.

white pellicle which has to be cast off before there can be freedom of motion; so that the insect may be said to molt as soon as it is born. Except in having a narrower pro-thorax, sloping roof-fashion to a median ridge, and in lacking wings, the young locust scarcely differs in structure from its parent; and the perfect winged form is gradually assumed through a series of four molts, during the first three of which the wing-pads become larger, and during the last, from the pupa (Fig. 25, *c*,) to the perfect state, the thorax becomes flattened, the wings are acquired and the insect ceases to grow and is ready to procreate. The time required from hatching till the wings are obtained averages about two months. The high and long flights characteristic to the species after the wings are acquired, are seldom indulged, except when there is a fair wind.

Just as the mature insects fly, as a rule, in a southeasterly direction, so the young, soon after they hatch, manifest the same desire to move toward the southeast. They are most active in the heat of the day, but are perhaps more ravenous at night. They migrate short distances every clear day, but do not like to cross a stream unless they can jump it. If driven into water, however, they kick about, making considerable progress, and do not easily drown. Such at least are the habits of the young hatched in the Mississippi Valley, though it is very probable that in their native table lands of the mountain region the migrating habit is not developed till they have acquired wings, and are forced from hunger to seek new quarters.

THE EGGS ARE LAID BY PREFERENCE

In bare, sandy places, especially on high, dry ground, which is tolerably compact and not loose. It is generally stated that they are not laid in meadows and pastures, and that hard road-tracks are preferred; in truth, however, meadows and pastures, where the grass is closely grazed are much used for ovipositing by the female, while on well traveled roads she seldom gets time to fulfill the act without being disturbed. Thus a well traveled road may present the appearance of being perfectly honey-combed with holes, when an examination will show that most of them are unfinished, and contain no eggs; whereas a field covered with grass-stubble may show no signs of such holes and yet abound with eggs. Furthermore, the insects are more readily

noticed at their work along roads and roadsides than in fields, a fact which has also had something to do in forming the popular impression. Newly broken or plowed land is not liked; it presents too loose a surface. Moist or wet ground is always avoided for the purpose under consideration. During the operation the female is very intent on her work and may be gently approached without becoming alarmed, though when suddenly disturbed she makes great efforts to get away and extricates her abdomen in the course of half a minute or more.

THE MIGRATORY INSTINCT AND GREAT DESTRUCTIVE POWER BELONG TO BUT ONE SPECIES WEST OF THE MISSISSIPPI.

Being anxious to ascertain whether the injuries reported in the different parts of the country between the Mississippi and the Rocky Mountains were all caused by one species, or whether others joined their forces in devastating the country, I took some pains to procure specimens from as many different localities as possible. What with specimens collected in previous years in Colorado, and received from Missouri and Texas, and those obtained in 1874, I now have material from Manitoba, Minnesota, Nebraska, Iowa, Colorado, Kansas, Missouri, Indian Territory and Texas. In each instance it is the same species that proves such a scourge. As we shall presently see, the same species occurs in Wyoming, Utah, Idaho, Nevada, Montana and Arizona. I know nothing of the migratory species which at times does damage in California and other parts of the country west of the Rocky Mountains; some have supposed it to be *Œdipoda atrox* Scudder; but I agree with Mr. Thomas that, with its comparatively short wings, this species cannot sustain lengthened flight, and the probability is that the *spretus* under consideration, or a race of it, is the culprit.

Only occasionally do specimens of some of the more common species accompany the migratory one. Thus the larger and common species, the Two-striped Locust (*Caloptenus bivittatus*, Say) and the Differential Locust (*C. differentialis*, Walk.) which are incapable of migrating to any great distance, and which are common in the Mississippi Valley, have occasionally been caught with the *spretus*, and sent to me with it. Already existing in the country invaded by the Rocky Mountain species, they were simply gathered up with it.

Yet, while no other species possesses such wonderful migratory habits, several become so enormously multiplied during certain years in their native homes as to commit very serious injury to vegetation. Of these, I shall speak more fully further on.

EASILY CONFOUNDED WITH THE RED-LEGGED LOCUST.

In my endeavors to accurately map out the territory in our State invaded in 1874 by the Rocky Mountain Locust, I have been frequently puzzled by accounts from counties east of the limit-line presently indicated. In every such instance, where I have been able to obtain specimens, they proved to be the common Red-legged Locust.

[Fig. 26.]

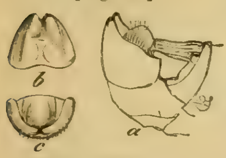
Red-legged Locust.

This last species is common in most of the States, extending to the Atlantic, and is even reported in parts of the Rocky Mountain region, where the Hateful species is at home. The two bear such a close general resemblance that even entomologists have doubted their specific distinctness; and indeed size and colorational characters would not suffice to separate the exceptional individuals which depart most from the typical characters of their species, and approach most to those of the other. Yet they are distinct, as species go, and in order to properly study the distribution of the Rocky Mountain species, and its power of becoming acclimated in the Mississippi Valley or not, it is of the first importance that observers confound not the two species. Hence, I shall describe in detail the two insects. From these details, which follow, it is evident that the distinguishing characters, most easily observed by the non-entomologist, are the relative length of wing, and the structure of the terminal joint of the male abdomen, which is turned up like the prow of a ship —this last character being the most important and constant. The Rocky Mountain species has the wings extending, when closed, about one-third their length beyond the tip of the abdomen, and the last or upturned joint of the abdomen narrowing like the prow of a canoe, and notched or produced into two tubercles at top. The wings of the Red-legged Locust extend, on an average, about one-sixth their length beyond the tip of the abdomen, and the last abdominal joint is shorter, broader, more squarely cut off at top, without terminal tubercles, and looking more like the stern of a barge.

[Fig. 27.]

Rocky Mountain Locust.

[Fig. 28.]



Rocky Mountain Locust:—Anal characters of male; *a*, side view; *b*, *c*, hind and top views, of tip.

[Fig. 29.]

Red-legged Locust: Anal characters of male; *a*, side view; *b*, *c*, hind and top views, of tip.

DESCRIPTIVE.

The large amount of material above referred to has enabled me to make very thorough comparisons between the two species. The genus *Coloptenus* to which the species belongs, is distinguished principally by the stoutness of the spine-like tubercle on the fore-breast between the front legs, and by the tip of the abdomen in the male being much swollen. Mr. Cyrus Thomas, in his admirable work on the "Acrididæ of N. A." has published good descriptions of the known N. A. species, and I will transfer what he has said of the two in question—adding only some subsidiary remarks in brackets, and at the close:

COLOPTENUS FEMUR-RUBRUM, Burm. Handb. Ent., II, 638.
Syn. *Acridium femur-rubrum*, Deg. Ins., III, Pl. 42, Fig. 5, p. 498.
" *femorale*, Oliv., Encyl. Meth., 121 Ins. VI, 228.
Gryllus (*Locusta*) *erythropus*, Gmel., Linn. Syst. Nat. I, IV, 2086.

"Grizzled with dirty olive and brown; a black spot extending from the eyes along the sides of the thorax; [but never onto the third lobe]; an oblique yellow line on each side of the body beneath the wings; a row of dusky, brown spots along the middle of the wing-covers; and the hindmost shanks and feet blood-red, with black spines. The wings are transparent, with a very pale greenish-yellow tint next to the body, and are netted with brown lines. The hindmost thighs have two large spots on the upper side, and the extremity black [more correctly three such spots, or including the extreme one at tip, four: Harris seems to have overlooked the basal one]; but are red below, and yellow on the inside. The appendages at the tip of the body in the male are of a long triangular form. Length from [to tip of abdomen] 0.75 to 1 inch; expansion of wings 1.25 to 1.75 inches." As this species, which is so common, varies considerably, I have concluded to give Dr. Harris's description without change, adding the following: Vertex but slightly depressed, with a minute angular expansion in front of the eyes; frontal costa usually but slightly sulcate; sides parallel. Eyes large and rather prominent. Elytra and wings generally a little [usually extending about 1-6 their length beyond the abdomen] longer than the abdomen. The cerci of the male rather broad and flat [longer and narrower towards tip than in spretus]; apex of last ventral segment entire and truncate. The yellow stripes on the side extend from the base of the wing to the insertion of the posterior femora. The ground color varies with localities and age, and most of the specimens from one or two sections appear to have unspotted elytra; sometimes a reddish-brown tint prevails; at others a dark-olive; at others a dark purplish-brown; yet the markings generally remain the same.

Localities.—Maine, Massachusetts, Connecticut, New York, Pennsylvania, Maryland, Tennessee, Illinois, Minnesota, Ohio, Nebraska, Missouri, Kansas, Colorado, Wyoming, Vancouver's Island (?), west coast of America (?)—[Thomas, *Acrididæ* of N. A. (1873), pp. 163-4.

In addition to what Mr. Thomas states of the variation in color, it may be added that the dark marks on the hind thighs are in exceptional specimens wholly wanting, and in others so confluent that the whole of the upper part is brown-black. In order to show how variable (within certain limits, however,) is the relative length of wing, I will add measurements of over eighty specimens, all taken in St. Louis county. As the length of the abdomen is an uncertain criterion, varying according as this last is distended with eggs or contracted from one cause and another, I have made these measurements from the juncture of the hind thighs and shanks. The specimens were killed in the cyanide bottle, and while yet fresh and supple laid flat on a scale divided into hundredths of an inch. The furthermost hind leg was then stretched until the suture between shank and thigh was just visible above the inner border of the front wings. Careful measurements were then taken, first of the whole body, second of the extent of wing beyond the base of shank, third of extent of abdomen beyond the the same. It will be understood that as the abdomen shrinks slightly in drying, and the wings do not, the figures in the fourth column in all these tables are somewhat lower than if taken from dry specimens. The tables showing these measurements will prove interesting when compared with that further on, giving similar measure-

ments of *spretus*, and conclusively show by comparing the figures in the fourth column that the specific distinction cannot, as Mr. Walsh thought, be safely and solely left to length of wing beyond the abdomen; as specimens of either species may approach each other in this respect to within the hundredth of an inch, and might be found to entirely agree if larger suites were compared. Nevertheless this relative length of wing has great value as a specific character, since of all the specimens measured, in even the longest winged *femur-rubrum* the wings fall short one hundredth of an inch of extending as far beyond the abdomen as they do in the shortest winged *spretus*. The anal characters of the male, (Fig. 29) will be found pretty constant and reliable. Yet they also vary and frequently approach *spretus* in the narrowing notched form of the tip. In the female the anal characters are of less value in distinguishing the species.

CALOPTENUS FEMUR-RUBRUM.

Measurements of the Male; in Hundredths of an Inch.

Whole length from front of head to tip of wing.	Length of wing beyond base of tibia.	Length of abdomen beyond base of tibia.	Length of wing beyond tip of abdomen.
0.95	0.03	0.03	0.00
1.05	0.04	0.03	0.01
1.00	0.03	0.02	0.01
1.03	0.04	0.03	0.01
1.03	0.04	0.03	0.01
1.03	0.05	0.03	0.02
0.98	0.02	0.00	0.02
1.08	0.05	0.03	0.02
0.97	0.02	0.00	0.02
1.06	0.10	0.08	0.02
1.03	0.04	0.02	0.02
0.94	0.02	0.00	0.02
1.06	0.08	0.05	0.03
1.10	0.09	0.06	0.03
1.02	0.03	0.06	0.03
1.04	0.05	0.02	0.03
1.10	0.08	0.04	0.04
0.95	0.09	0.05	0.04
0.99	0.08	0.04	0.04
1.05	0.08	0.04	0.04
1.08	0.09	0.05	0.04
1 08	0.10	0.06	0.04
1.09	0.08	0.03	0.05
0.99	0.05	0.00	0.05
1.04	0.05	0.00	0.05
1.05	0.06	0.00	0.06
1.12	0.12	0 05	0.07
1.05	0.08	0.00	0.08

Measurements of Female.

1.22	0.13	0.15	0.00
1.15	0.13	0.15	0.00
1.05	0.04	0.05	0.01
1.08	0.09	0.10	0.01
1.20	0.13	0.14	0.01
1.15	0.03	0.03	0.01
1.03	0.04	0.04	0.01
1.10	0.06	0.05	0.01
1.06	0.03	0.02	0.01
1.06	0.03	0.02	0.01
1.08	0.03	0.02	0.01
1.08	0.04	0.03	0.02
1.05	0.03	0.02	0.02
1.09	0.06	0.04	0.02
1.15	0.14	0.12	0.02
1.04	0.02	0.00	0.02
1.08	0.02	0.00	0.02
1.04	0.03	0.00	0.03
1.09	0.08	0.05	0.03
1.03	0.03	0.00	0.03
1.08	0.12	0.09	0.03
1.04	0.03	0.00	0.03
1.10	0.06	0.03	0.03
1.13	0.14	0.10	0.04

Measurements of Female—Continued.

Whole length from front of head to tip of wing.	Length of wing beyond base of tibia.	Length of abdomen beyond base of tibia.	Length of wing beyond tip of abdomen.
1.13	0.08	0.04	0.04
1.08	0.04	0.00	0.04
1.13	0.09	0.05	0.04
1.18	0.12	0.08	0.04
1.13	0.09	0.05	0.04
1.15	0.13	0.08	0.05
1.09	0.08	0.03	0.05
1.15	0.13	0.08	0.05
1.19	0.15	0.10	0.05
1.19	0.14	0.09	0.05
1.04	0.05	0.00	0.05
1.19	0.14	0.08	0.06
1.15	0.14	0.08	0.06
1.18	0.08	0.02	0.06
1.18	0.14	0.08	0.06
1.13	0.09	0.03	0.06
1.13	0.09	0.02	0.07
1.06	0.10	0.03	0.07
1.09	0.10	0.03	0.07
1.13	0.10	0.03	0.07
1.15	0.10	0.03	0.07
1.15	0.08	0.00	0.08
1.12	0.08	0.00	0.08
1.14	0.15	0.06	0.09
1.18	0.09	0.00	0.09
1.10	0.13	0.04	0.09
1.16	0.12	0.03	0.09
1.19	0.23	0.12	0.11
1.15	0.14	0.03	0.11
1.13	0.12	0.00	0.12

CALOPTENUS SPRETUS Uhler Mss.

Syn., *Acridium spretum** Thos. Trans. Ill. St. Agr. Soc, V, 450.

Very much like *C. femur-rubrum*, Burm., the principal difference being in the length of the elytra and wings; a notch at the tip of the last [♂] ventral segment. Posterior lobe of the pronotum slightly expanding; median somewhat distinct. Elytra and wings pass the abdomen about one-third their length. The last [♂] ventral segment, which is turned up almost vertically, is somewhat tapering and is notched at the apex, which distinguishes it from the *femur-rubrum*; the notch is small, but is distinct. Prosternal spine robust, sub-cylindrical, transverse. Migratory.

Color.—Scarcely distinct from the *C. femur-rubrum*. The occiput and disk of the pronatum generally reddish-brown; the posterior lobe somewhat paler than the anterior and middle. Spots, as in *femur-rubrum*, arranged in a line along the middle of the elytra; these are a little larger and more abundant towards the apex. The head and thorax are sometimes a very dark olive-brown, at others, reddish-brown, and even brownish-yellow, the color deepening with age. The wings are pellucid, nerves dusky toward the apex; when flying high and against the sun, their wings look like large snow flakes.

Dimensions.—♀ Length, [to tip of abdomen] 1 to 1.2 inches; elytra as long as the body; posterior femora, 0.55 inch; posterior tibiæ, 0.5 inch. ♂ Length, 0.85 to 1 inch; elytra, 0.9 to 1.05 inches.

*This is called "*Acridium spretis*, Uhler" in the article alluded to, and I very much doubt if the description refers to the species in question; first, because I do not believe that *spretus* occurs in Murphysboro, Ills., where Mr. Thomas was then residing, and where he quotes *Acridium spretis* as being quite common; secondly because the description in some respects would not apply to *spretus* as at present defined. I call attention to this discrepancy, because it is upon this (as I believe erroneous) reference, that Mr. Thomas quotes *spretus* from Illinois; whereas I agree with Mr. Walsh that (as we understand the species to-day) it is not indigenous to that State. Where the anal characters of the male are not carefully given, it is impossible to be sure of the species.

Illinois [very questionable], Iowa, Missouri, Nebraska, Kansas, Colorado, Wyoming, Utah, Idaho, Nevada, Montana, Minnesota, and Dakota. (Thomas, by examination and collections in person); Minnesota, Wisconsin [doubtful], Dakota (Scudder); Texas, Arizona, British America (Thomas)—[Thomas, *Acrididæ* of N. A., pp. 164–5.

Regarding coloration, as with *femur-rubrum*, it is quite variable, and the dead specimens convey a very imperfect idea of the living colors, which are thus given in my notes taken in the field. The more common specimens are yellowish-white beneath; glaucous across the breast and about mouth-parts; pale bluish-glaucous—often with shades of purple—on the sides of the head and thorax and on the front of the face; olive-brown on the top of head and thorax; pale beneath, more or less bluish above and marked with black, especially towards base, on the abdomen. The front wings have the ground-color pale grayish-yellow, inclining to green, and their spots and veins brown; the hind wings, except a yellowish or brownish shade at apex and along the front edge and a green tint at base, are transparent and colorless, with the veins brown. The front and middle legs are yellowish. The hind legs have the thighs striped with pale glaucous and reddish on the outside and upper half of inside, with four broad black or dusky marks on the upper edge, the terminal one extending beneath around the knee. The shanks are coral-red with black spines; the feet somewhat paler, with black claws; antennæ pale yellow; palpi tipped with black. In the dead specimens all these colors become more dingy and yellow. Palpi and front legs in some specimens tinged with red or blue; the hind tibiæ sometimes yellowish instead of red, especially in the middle.

Larva—When newly hatched, the larva is of a uniform pale gray without distinctive marks. It soon becomes mottled with the characteristic marks however. After the first molt the hind thighs are conspicuously marked on the upper outside with a longitudinal black line; the thorax is dark with the median dorsal carina and two distinct lateral stripes pale yellow, the black extending on the head behind the eyes. The sides of the thorax then become more yellow with each molt, the black on the hind thighs less pronounced, and the face at first black and then spotted. The occiput and abdomen above are mottled with brown, the former marked with a fine median, and two broader anteriorly converging pale lines, the latter with two rather broken lateral lines of the same color.

Pupa—The pupa is characterized by its paler, more yellow color, bringing more strongly into relief the black on the upper part of the thorax and behind the eyes; by the spotted nature of the face, especially along the ridges, by the isolation of the black subdorsal mark on the two anterior lobes of prothorax, and by the large size of the wing-pads, which—visible from the first molt and increasing with each subsequent molt—are now dark, with a distinct pale discal spot, and pale veins and borders. The hind shanks incline to bluish rather than red as in the mature insect.

In the following table of measurements, introduced for comparison with that given of *femur-rubrum*, the same rules were adopted as in the other case, and particular pains were taken to get specimens from as many parts of the ravaged country as possible; also, by study of the structural and other peculiarities of *spretus* to guard against the chance mixing of specimens of *femur-rubrum*.

CALOPTENUS SPRETUS.

Measurements of the Male; in Hundredths of an Inch.

Whole length from front of head to tip of wing.	Length of wing beyond base of tibia.	Length of abdomen beyond base of tibia.	Length of wing beyond tip of abdomen.
1.24	0.25	0.05	0.20
1.20	0.28	0.08	0.20
1.29	0.28	0.08	0.20
1.18	0.33	0.12	0.21
1.26	0.25	0.03	0.22
1.22	0.29	0.06	0.23
1.10	0.29	0.05	0.24
1.33	0.29	0.04	0.25
1.33	0.35	0.09	0.26
1.24	0.29	0.03	0.26
1.29	0.35	0.08	0.27
1.30	0.32	0.05	0.27
1.30	0.35	0.08	0 27
1.28	0.35	0.08	0.27
1.29	0.32	0.05	0.27
1.24	0.30	0.03	0.27
1.19	0.33	0.06	0.27
1.28	0.36	0.09	0.27
1.28	0.30	0.02	0.28
1.24	0.38	0.09	0.29
1.35	0.39	0.10	0.29
1.23	0.38	0.09	0.29
1.35	0.35	0.05	0.30
1.35	0.40	0.10	0.30
1.35	0.34	0.03	0.31
1.30	0.34	0.03	0.31
1.33	0.33	0.02	0.31
1.25	0.34	0.03	0.31
1.32	0.34	0.03	0.31
1.30	0.34	0.03	0.31
1.18	0.34	0.02	0.32
1.38	0.40	0.08	0.32
1.38	0.42	0.09	0.33
1.40	0.38	0.05	0.33
1.28	0.38	0.05	0.33
1.30	0.35	0.02	0.33
1.24	0.38	0.04	0.34
1.30	0.38	0.03	0.35
1.40	0.38	0.03	0.35
1.33	0.35	0.00	0.35
1.33	0.38	0.03	0.35
1.35	0.38	0.02	0.36
1.34	0.38	0.02	0.36
1.29	0.38	0.02	0.36
1.33	0.35	0.02	0.37
1.36	0.43	0.06	0.37
1.38	0.34	0.05	0.39
1.33	0.36	0.03	0.39

Measurements of Female.

1.25	0.28	0.15	0.13
1.23	0.33	0.18	0.15
1.28	0.40	0.23	0.17
1.34	0.30	0.12	0.18
1.38	0.40	0.22	0.18
1.29	0.24	0.06	0.18
1.33	0.38	0.19	0.19
1.44	0.38	0.19	0.19
1.25	0.39	0.19	0 20
1.38	0.43	0.23	0.20
1.24	0.33	0.13	0.20
1.25	0.32	0.12	0.20
1.15	0.33	0.13	0.20
1.35	0.42	0.20	0.22
1.28	0.40	0.18	0.22
1.30	0·40	0.18	0.22
1.33	0.43	0.20	0.23
1.29	0.28	0.05	0.23
1.35	0.33	0.10	0.23
1.16	0.36	0.13	0.23
1.48	0.38	0.15	0.23

Measurements of Female—Continued.

Whole length from front of head to tip of wing.	Length of wing beyond base of tibia.	Length of abdomen beyond base of tibia.	Length of wing beyond tip of abdomen.
1.28	0.38	0.15	0·23
1.30	0.36	0.13	0 23
1.29	0.36	0.12	0.24
1.30	0.42	0.18	0.24
1.33	0.28	0 04	0.24
1.35	0.32	0.08	0.24
1.33	0.39	0.15	0.24
1.30	0.42	0.18	0.24
1.35	0.43	0.19	0.24
1.26	0.30	0.06	0.24
1.38	0.40	0.16	0.24
1.33	0.36	0.12	0.24
1.24	0.33	0.08	0.25
1.29	0.38	0.13	0.25
1.45	0.43	0.18	0.25
1.50	0.43	0.18	0.25
1.33	0.33	0.08	0.25
1.30	0.43	0.18	0.25
1.30	0.33	0.08	0.25
1.25	0.30	0.04	0.26
1.30	0.35	0.09	0.26
1.28	0.32	0.06	0.26
1.34	0.30	0.04	0.26
1.36	0.34	0.08	0.26
1.25	0.38	0.12	0.26
1.45	0.52	0.16	0.26
1.45	0.44	0.18	0.26
1.25	0.30	0.04	0.26
1.39	0.45	0.18	0.27
1.52	0.40	0.13	0.27
1.26	0.36	0.09	0.27
1.28	0.40	0.13	0.27
1.28	0.35	0.08	0.27
1.33	0.33	0.06	0.27
1.33	0.35	0.08	0.27
1.28	0.35	0.08	0.27
1.26	0.39	0.12	0.27
1.38	0.42	0.15	0.17
1.30	0.40	0.13	0.27
1.23	0.35	0.08	0.27
1.43	0.30	0.02	0.28
1.29	0.36	0.08	0.28
1.28	0.38	0.10	0.28
1.30	0 36	0.08	0.28
1·35	0.43	0.15	0.28
1.30	0.43	0.15	0.28
1.33	0.38	0.10	0.28
1.38	0.42	0.13	0.29
1.15	0.38	0.09	0.29
1.38	0:42	0.13	0.29
1.35	0.42	0.13	0.29
1.36	0.39	0.10	0.29
1.29	0.38	0.09	0.29
1.38	0.43	0.14	0.29
1.28	0.38	0.09	0.29
1.33	0.39	0.10	0.29
1.36	0.34	0.04	0.30
1.45	0.43	0.13	0.30
1.38	0.33	0.03	0.30
1.35	0.40	0.10	0.30
1.38	0.39	0.08	0.31
1.29	0.35	0.04	0.31
1.38	0.35	0.03	0.32
1.42	0.48	0.16	0.32
1.30	0.40	0.18	0.32
1.43	0.38	0.06	0.32
1.25	0.35	0.03	0.32
1.46	0.44	0 12	0.32
1.33	0.36	0 04	0.32
1.24	0.36	0.03	0.33
1.34	0.45	0.12	0.33
1.35	0.43	0.10	0.33
1.35	0.45	0.10	0.35
1.32	0.38	0.03	0.35
1.33	0.38	0.03	0.35
1.43	0.45	0.10	0.35
1.38	0.42	0.04	0.38
1.53	0.49	0.10	0.39

Finally, to sum up the differences between the two species, besides the structural and more reliable characters already given, in general terms, *spretus* compared to *femur-rubrum*, may be distinguished by the following less reliable and more inconstant characters: It is the larger species; the antennæ are slightly shorter and paler; the occiput and two anterior lobes of the prothorax are more livid and darker; the third lobe of prothorax broader; the dark, subdorsal, prothoracic mark running from the eyes less pronounced; the oblique, yellow line from base of wings to base of hind thighs more often obsolete; the front wings paler toward tips, more ferruginous at base, with larger, more conspicuous spots; the anal abdominal joint of male also much paler; the cerci and valves in the female generally shorter and more robust.

Such are the distinguishing features between these two insects, when the more typical specimens of the western *spretus* are compared with *femur-rubrum* as it occurs around St. Louis. That these distinguishing features will lose their value in proportion as abundant material from all parts of the country is examined and compared, I have not the least doubt; for I have already shown that such is the fact so far as coloration and length of wing is concerned, and the meagre material which I have from the East indicates considerable variation and approach in the more important structural characters. In considering the ravages of migratory locusts in the Atlantic States, I shall recur to this subject.

CHRONOLOGICAL HISTORY.

The plague of locusts is as old, nay older, than the Bible, where, in Exodus, we are told how they went up over the land of Egypt and "covered the face of the whole earth, so that the land was darkened; and they did eat every herb of the land, and all the fruit of the trees which the hail had left; and there remained not any green thing in the trees, or in the herbs of the field, throughout all the land of Egypt."* Paulus Orosius tells us that in the year of the world 3,800, such infinite myriads of locusts were blown from the coast of Africa into the sea and drowned, that, being cast upon the shore, they emitted a stench greater than could have been produced by the carcasses of one hundred thousand men, and caused a general pestilence.† Numerous, indeed, are the accounts of general devastation, pestilence and famine that have frequently followed in the wake of these locusts in the East, and travelers in South Africa, Asia and South Europe, have left us abundant records of the fearful devastations of this "Army of the Great God," as the Arabs term these migrating hosts. Their history is one of dire calamity and desolation; and their devastations have become part of the history of nations: they have even been perpetuated in coins. Those who have the curiosity to acquaint themselves with the history of locusts in the more ancient parts of the world, cannot do better than refer to Kirby and Spence,‡

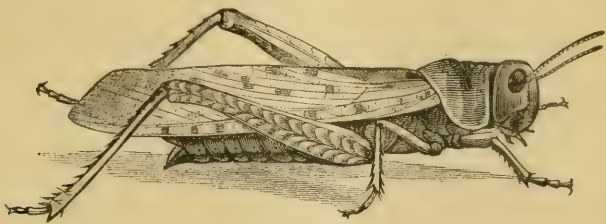
* Exodus, X, 15.

† Oros, *Contra Pag*. 1, V., c. 2.

‡ Introduction to Ent. I., Letter VII., London, 1828.

or to the compilation published in this country by Frank Cowan.* It suffices here to state that the injuries by locusts in the desert countries bordering mountain ranges in the East, are by no means matters of past history only, but that they are felt occasionally at the present time as they have been for all time past. In 1866, during the same year as our previous great invasion, Algeria and the whole country in the north of Africa, was severely visited, causing the famine of 1867, and the epidemics which followed; and even in 1874, these insects caused serious alarm in the same parts of Africa; and M. H. Brocard tells us that in the three subdivisions of Constantine, Setif and Batna, 4,820 hectolitres (about 14,000 bushels) of eggs were collected.† The species most conspicuous in its devastations, especially in Central Europe, is the Migratory Locust (*Œdipoda migratoria*, Linn), though in Africa and Asia the *Acridium perigrinum* and the *Caloptenus Italicus* have similar destructive and migratory powers. All these insects belong to the same family as our own species, and the last named, even to the same genus.

[Fig. 30.]



MIGRATORY LOCUST OF EUROPE.

While the chronological record of Locust invasions and devastations in the "Old World," is full and complete, the record of such invasions in our own country, has never been fully written. The most complete record that I know of, is that by Alexander S. Taylor, of Monterey, Cal., published in the Smithsonian Report for 1858, (pp. 200–213), to which I am indebted for the earlier accounts, which follow: From what is here given, it is very evident that these insects have occasionally proved great plagues from the earliest settlement of the country; and there can be no doubt that from time immemorial, or since our continent assumed its present configuration, they have from time to time played the same róle of devastators, and that the only exceptional circumstance about the 1874 irruption, compared to those of former years, was the larger area of settled and cultivated country devastated, and the consequent greater amount of distress entailed.

* Curious History of Insects, pp. 101—31, Phila., 1865.

† *Comptes Rendus*, Paris Academy, Jan. 25, 1875.

The earliest record I can find of Locust injuries in America, is in Gage's West Indies, and they date back to the year 1632. In speaking of their visitation in Guatemala, he says:

"The first year of my abiding there it pleased God to send one of the plagues of Egypt to that country, which was of Locusts, which I had never seen till then. They were after the manner of our Grasshoppers, but somewhat bigger, which did fly about in numbers so thick and infinite that they did truly cover the face of the sun, and hinder the shining forth of the beams of that bright planet. Where they lighted, either upon trees or standing corn, there was nothing expected but ruin, destruction and barrenness; for the corn they devoured, the fruits of trees they ate and consumed, and hung so thick upon the branches that with their weight they tore them from the body. The highways were so covered with them that they startled the traveling mules with their fluttering about their heads and feet. My eyes were often struck with their wings as I rode along; and much ado I had to see my way, what with a montero wherewith I was fain to cover my face, what with the flight of them which were still before my eyes. Where they lighted in the mountains and highways, there they left behind them their young ones, which were found creeping upon the ground, ready to threaten such a second year's plague, if not prevented; wherefore all the towns were called, with spades, mattocks and shovels, to dig long trenches and therein to bury the young ones."

The early Jesuit missionaries of California have left numerous records of their injuries on the Pacific Coast. Father Michael del Barco records their visitations in California in 1722, 1746 and the three succeeding years; also in 1753, 1754, and 1765. Clavigero, in his History of California, also gives a very full description of these pests.

In 1827, 1828 and 1834, they destroyed all the crops in the rancheros and missions, and in 1838 and 1846, again did great damage in upper California. "For more than half a century they have troubled the Argentine Republic in South America. In a latitude corresponding with Louisiana and Texas, but in the southern hemisphere they have made agriculture worthless, and rendered the settlement of that magnificent country between the Andes and the Atlantic Ocean, by a dense population, impossible."* Dr. B. A. Gould gives a graphic account of a swarm of locusts in 1873 that devastated Cordoba, a swarm at least twenty miles in length and six miles in breadth, extending for an altitude of 5° like a thick, black trail of smoke. † Of the ravages of locusts in the Atlantic States, I shall speak more particularly in a future chapter: We have records of great injury from locusts in New Hampshire, Massachusetts and Vermont, at several periods during the latter part of the last century.

Coming now to the chronological history of the particular Rocky Mountain species in question, anything like substantial records fail us, and in order to give the following summary of its devastations during the present century, I have had to ransack the files of hun-

*Rev. Edw. Fontaine, in New Orleans *Times*, March, 1866.

† Amer. Journ. of Sc. Dec. 1873.

dreds of periodicals, and to depend on a number of fugitive articles published during the last twenty years.

In 1818 and 1819, according to Neill's History of Minnesota, vast hordes of grasshoppers appeared in Minnesota, eating everything in their course; in some cases the ground being covered three or four inches thick. In the same years they were extremely injurious in the Red River country in Manitoba. In 1820, or the succeeding year, we hear of them falling upon the western counties of Missouri, as described in the following items:

"We were informed by old residents of West Missouri and some of the Indians, that long ago, I think it was in 1820, there was just such a visitation of grasshoppers as is now afflicting us. They came in the Autumn by millions, devouring every green thing, but too late to do much harm. They literally filled the earth with their eggs, and then died. The next Spring they hatched out, but *did but little harm*, and when full-fledged left for parts unknown. Other districts of country have been visited by them, but so far as I could learn, they have done but little harm after the first year."—[S. T. Kelsey, Ottawa, (now of Hutchinson,) Kansas, in *Prairie Farmer*, June 15, 1867, p. 395.

A Missouri paper publishes a statement by an old settler, that great numbers of grasshoppers appeared in September, 1820, doing much damage. The next Spring they hatched out, *destroying the cotton, flax, hemp, wheat and tobacco crops;* but the corn escaped uninjured. About the middle of June they all disappeared, flying off in a southeast direction.—*Western Rural*, 1867.

It is reasonable to suppose that these 1820 swarms also ravaged Kansas and the country to the northwest, very much as they did in 1874, though no records of the fact are to be found, for the simple reason that the western country was unsettled by farmers. We know that the crops were destroyed in many parts of Manitoba during the same and the previous year, and the migrations of 1819 and 1820 must have been very similar to those of 1873 and 1874.

In 1845 and again in 1849, we have accounts, from various sources, of their swarming in Texas. In 1855 there was another very general irruption all over the western part of the continent. Says Mr. Taylor, in the Smithsonian Report already alluded to: "Up to the 11th of October, 1855, and commencing about the middle of May, these insects extended themselves over a space of the earth's surface much greater than has ever before been noted. They covered the entire Territories of Washington and Oregon, and every valley of the State of California, ranging from the Pacific Ocean to the eastern base of the Sierra Nevada; the entire Territories of Utah and New Mexico; the immense grassy prairies lying on the eastern slopes of the Rocky Mountains; the dry mountain valleys of the republic of Mexico, and the countries of Lower California and Central America; and also, those portions of the State of Texas which resemble, in physical charactertstics, Utah and California. The records prove that the locusts extended themselves, in one year, over a surface comprised within thirty-eight de-

grees of latitude, and, in the broadest part, eighteen degrees of longitude.

"On several days in June, July and August, of 1855, the grasshoppers (or *langostas* of the Spaniards) were seen in such incredible numbers in the valley of Sacramento, in California; in the valley of Colima, in Southwest Mexico; in the valley of the Great Salt Lake; in Western Texas, and in certain valleys of Central America, that they filled the air like flakes of snow on a winter's day, and attacked everything green or succulent with a voracity and despatch destructive to the hopes of the agriculturalists."

They are described as reducing the Mormons of Salt Lake, during that year, to a simpler diet than that of John the Baptist, for the people had to fall back on the locusts without the honey; and they caused a good deal of suffering in the then Territories of Kansas, Nebraska and Minnesota. The Summer of 1855, like that of 1874, was exceedingly dry—the driest in fact that had been known for ten years.

In 1856 they again made their appearance in parts of Utah, California and Texas, but in diminished numbers. In Minnesota, however,* and in West and Northwest Iowa their ravages during this year seem to have been greater.

In 1857 we hear of them again in various parts of the Northwest † and around the Assiniboine settlement in Manitoba,‡ and they destroyed the entire crop of a region of country extending from the base of the third plateau to the Gulf of Mexico, 150 miles in length, and about 80 in breadth, including the entire valley of the Gaudaloupe, and much of the territory watered by the Colorado and San Antonio rivers. Throughout this whole area of 12,000 square miles every green thing cultivated by man was consumed, and how much further northwest the ravages extended is not known.‖ They reached as far East as Central Iowa.§

It is probable that part of the injury reported in 1856 and 1857 east of the Rocky Mountains was caused by the progeny from the immense swarms that swept over the country in 1855; and it is quite likely that some of them reached Missouri, for Mr. H. B. Palmer, of Hartville, has related to me how, about 1857, these insects passed through a portion of Wright county, from N. to S., stripping everything on their way.

* Rep. of Dept. of Agr. 1863, p. 36.

† Walsh's Ills. Ent. Rep. pp. 92-3: *Prairie Farmer*, April 25, 1868.

‡ *Canada Farmer* Aug. 15, 1874.

‖ Rev. E, Fontaine, *loc. cit.*

§ *Prairie Farmer*. April 25, 1868.

In 1860, as several Kansans have informed me, these locusts came and did much damage around Topeka, remaining a few days and leaving the last of August. This must have been a limited and rather local swarm.

In 1864 we again hear of locust invasions into Manitoba, Minnesota, and around Sioux City, Iowa, and their eggs hatched and the young did much damage the following year, 1865. In Colorado one of the most destructive visitations ever known there come in 1864 from the northwest, doing much damage, as did the progeny in 1865.

The year 1866 was another marked locust year, and the first, since that of 1855, in which the damage was sufficiently great and widespread to attract national attention. The insects swarmed over the Northwest and did great damage in Kansas, Nebraska, and Northeastern Texas, and invaded the western counties of Missouri very much as they did the past year. They came, however, about a month later than in 1874. They were often so thick that trains were seriously delayed on account of the immense numbers crushed on the track. Mr. Walsh has published a full record of this invasion in the Report already cited.*

In 1867 the progeny of those which fell upon the country the previous year did more or less damage, which was extensively reported during the early part of the growing season. Later in the season, however, fresh swarms came from the Rocky Mountain region and fell upon the fertile plains of the Mississippi Valley. Thus there were two fresh invasions, the one following the other, in the years 1866 and 1867; an occurrence which is quite exceptional, and to which the immense damage done during the latter year is, in great part, attributable. Mr. Walsh (*loc. cit.*) has given us, at great pains, a pretty full record of the doings of locusts in 1867, and from said record he makes it quite clear that the invasion of 1866 was followed in 1867 by a fresh, though less extensive one, direct from the Rocky Mountain region. I may add that a number of scraps and records of the insect's doings during those two years, other than those he has brought together, bear out his deductions. The locusts also fell upon Utah in immense swarms in 1867.

During the subsequent years of 1868 and 1869 we hear more or less of the remnants of these two vast swarms from the mountain region, and of their injury in the Mississippi Valley; but their numbers are always diminishing and their enemies increasing, so that during the latter year not a healthy individual was to be found, and in 1870

*First Annual Rep. as Acting State Ent. of Ills., pp. 83-4 (1868).

the race had about vanished from the invaded country—at least from its more eastern portions. I shall here bring together a few items and communications that will serve to continue the chronological history of the pest during these two years; confining the extracts to those cases where I have, in each instance, been able to verify, by specimens, the species referred to, as the genuine *spretus*.

In passing over into Kansas, the corn for a few miles was of a splendid appearance and rapidly maturing, but we soon came into the grasshopper country, where corn, by the thousands of acres, was stripped as clean as a field of bean poles, and entirely covered. The gardens had been completely denuded of all vegetables, and all that were used west of Fort Riley were carried from Leavenworth and further east. In returning through Northern Missouri, we found better prospects for all the crops; at Cameron Station we were shown stalks of corn sixteen feet high, heavily eared, as a sample ot many fields.—[H. D. Emery, in *Prairie Farmer*, Fall of 1868.

On Saturday, the 8th of August, the grasshoppers returned. During the night of the 7th, a strong wind commenced blowing from the northwest, which steadily continued during the next day. As early as nine o'clock A. M., large numbers of grasshoppers could be seen flying very high up; at about three o'clock P. M., the wind ceased to blow so strong although a good breeze was kept up. The grasshoppers commenced lighting, which they did in fearful numbers, in many places bending the tops of the corn-stalks on which they settled, and commenced their work of destruction. They are yet with us, and have already injured the corn crop, in many fields, much. All the early corn is too far advanced to receive any damage from them; but much of the corn crop is late because of the work of the grasshoppers hatched out here last Spring. This late crop will be much injured from the fact that it is just tasseling and shooting, and the pesky things appear to have a great liking for the tender silks and shucks on the ends of the just forming ears. With the silk eaten off, and the tassel much injured, fears are entertained that inferior ears will be formed. * * * —[S. H. K., Page county, Iowa, *ibid*, Aug. 10, 1868.

On Saturday, the 7th, in the afternoon, the "red-legged" locusts began "to pour into" this region of country, and they have been as industrious as "circumstances would permit." The cabbage, potato-vines, beets, onion-tops, and other vegetables were "pressed into service" in a short space of time. Some of my peaches are stripped of leaves; other trees only in part. The apple trees and Kirtland raspberry canes were denuded of their foliage; they even devoured the leaves of the walnut and other forest trees. Many of the weeds indigeneous to the country shared the same fate as the tender vegetables. The cherry and some seedlings of the wild cherry tree of Pennsylvania are exempt from their attacks. The foliage of the hickory appears to be a favorite dish with them.

The grape vine leaves have not escaped entirely, but Concord, Rebecca, Diana and some other varieties appear to be preferred to Clinton, Franklin and that more excellent Isabella, together with some other kinds. My young pears have been so far uninjured, but the trouble is that the ground in certain spots is literally covered with them. On Sunday, there were millions of them that made an effort to leave, but a Southeasterly wind prevented them, and they lit on the ground again.

They have, as yet, done very little damage to the blackberry plants. The rare kinds of this region that I am testing, such as the Missouri Mammoth, Wilson and Kittatiny, I covered with prairie hay, which being old they will not eat while there is anything green and tender. They do not appear to be devotedly attached to the Doolittle raspberry, as but few canes are yet leafless. On Sunday night we had a heavy rain, accompanied with thunder and lightning, which will prevent them from starting in large numbers this morning. They are evidently bound for the south. A great many left this forenoon for that direction. Many would rise a few rods in the air, but again return. They have denuded thousands of acres of corn in this region, but the extent of damage done at a distance from here I have not yet learned.—[A. M. Burns, Riley county, Kansas, *ibid*, Aug. 22, 1868.

We have many grasshoppers. When they are small they seem most destructive. Early in the season they stripped oats and wheat indiscriminately; now they work on the wheat principally. Some wheat-fields are entirely destroyed by them, and on other fields they are eating off all the blades and youngest shoots. They have commenced on the corn. Some few are now getting their wings. Enclosed I send you

specimens. A great many were hatched out last week, and millions were killed all along by heavy rains and some few by birds, etc.—[Extract from a private letter from Uriah Bruner, Omaha, Nebraska, June 8, 1868.

Enclosed find grasshoppers. The two with strings attached have parasites on their wings, and it is asserted by many that thousands have been killed by those lice. The grasshoppers are leaving about as fast as they can fly, and some are coming from other parts. We have less now than we had some time ago. Wheat and some or most kinds of garden vegetables the grasshoppers devour as fast as they can, while prairie grass, oats, etc., though they are just as plenty on, they seem to eat a great deal less of, probably not more than is necessary to subsist them.—[Letter extract from same, June 19, 1868.

The history of these grasshoppers, as far as it relates to this part of the country, is as follows: About the last of September, 1866, they made their appearance for the first time, so far as I know, in this part of the country. They came in millions from the south, southwest and west, and were so numerous as to almost darken the sun: in other words, the heavens seemed from about ten in the morning till three in the afternoon to be filled with them. They lit, ate up cabbages, Fall wheat and nearly destroyed many meadows. They cohabited, and shortly after deposited their eggs in the ground in countless millions. In the Spring the eggs hatched, and after they had obtained the full size they rose in the air and were carried away to other parts.

In 1867 they came again and deposited their eggs in the Fall, and the specimens I send are from them. The number of eggs deposited last Fall was not as great as in the Fall of 1866.

The grasshoppers hatched here injure our Spring crops and then leave, to be followed in the Fall by others from the far West to prey upon our fall vegetation and deposit their eggs for another crop. One farmer told me a few days ago that the damage which he sustained from them last year could not have been less than $1,500. Last Fall I put in some Fall wheat which was entirely consumed by them. * * *

I am of the opinion that stirring the ground in the Fall exposed the eggs to the action of the frost and destroyed many of them, as but few were seen there this Spring. The hogs in the Spring root the ground over for their eggs and destroy many of them. * * * —[Letter extract from Stephen Blanchard, Oregon, Holt county, Missouri, July 13, 1868.

* * This morning and some portion of yesterday the wind was in the east, but this morning soon changed to the west, and we thought about 10 o'clock that it would rain, but about noon, or perhaps a little before, the wind changed to the north, and about 2 o'clock the grasshoppers began to fall about as fast as the flakes of snow fall, until the ground was *literally covered with them.*—[Letter extract from same, Aug. 10, 1868.

My corn has been quite badly injured by the "Western Locust." I have a small orchard of about 200 trees that have been greatly injured.

My trees set out this Spring (about 50) are as naked of leaves as they should be in February next. The trees set out a year ago are badly injured, and so are those set out three years ago. If you will send me by mail a little of the article which you recommend I will most gladly try it, and will give you the results. They have been coupling for increase for several days past. They are not now as numerous as they have been, and if they leave before they deposit their eggs in the ground for Spring hatching we may get rid of them.

It may be also that as it is so much earlier than heretofore when they came, that their eggs might hatch this Fall. In this case they will not do us much injury in the Spring for the reason that the Winter would kill them.—[Letter extract from same, Aug. 24, 1868.

I send you herewith, specimens of the Red-legged Locust, which frequently overruns our extreme western regions, but appeared *here* for the first time last Fall. They are quite as ruinous to us as Yankee carpet-baggers and scallawags! I will give you a brief sketch of them also—the *insect* Locusts, not the others!—[Extract from a private letter from the late Thos. Affleck, Brenham, Washington county, Texas, July 20, 1868.

Those hatched from eggs which were deposited after migrating to this country, so distant from their natural habitat, *do not copulate before their departure hence.* That you may record as a fact, general, I think, if not universal.—[Letter extract from same, Aug. 22, 1868.

In the Appendix will be found a letter from Mr. Affleck giving a more full and interesting account of his experience with this pest.

during 1868. That the insect was more or less injurious, in 1868, throughout the region invaded the two previous years is proved from various records of their hatching out, and their injuries around Salt Lake City, Utah, and by the fact that the Red River settlement appealed to the Canadian Government for aid, on account of their devastations during that year. They are reported as having been quite numerous in Andrew, Cedar, Clinton, Daviess, Gentry, Jackson, Nodaway in our own State, by the different correspondents who replied to my circular. They also attracted some attention in Kansas during the fore part of August, and during the preceding month in Iowa and Minnesota.*

In 1869 there were still some remnants left of the 1867 invasion. I received some from Leavenworth, Kansas, sent in a tin box, and in reaching me there was but one left, which, having eaten up the others, was master of the situation. They hatched out in countless numbers from the 20th to 24th of March, in Holt county, Mo.,† and were destructive east of Nemaha county, Kansas; but the following items from the *Prairie Farmer* "Record of the Season," will indicate how more and more impotent they became:

> Great numbers of the "Red-Legged Locust"—grasshoppers—have hatched out this Spring, but have done very little harm thus far, their ravages being almost wholly confined to the more tender garden vegetables.—[C. W. D., Saline county, Kansas, June 22, 1869.
>
> The "hateful grasshoppers" are very bad in sandy districts, and, when full fledged, they will visit every farmer, and take their portion.—[C., Denver, Col., July 6, 1869.
>
> Grasshoppers all left as soon as they could fly, and there has no new crop come in since. Apples were not injured here; peaches were, to some extent, but there will be a fair yield. Wild fruits of all kinds are abundant.—[J. W. O., Brown county, Kansas, August 16, 1869.
>
> The grasshoppers hatched out here last Spring, but did very little damage; they all left as soon as they could fly, and I hope it will be long before they pay us another visit. There is not much fruit raised here yet, but what there is is pretty good.—[W. S. S., Page county, Iowa, September 4, 1869.

The following letter, communicated to me, August 27, 1869, by S. K. Faulkner, M. D., of Whitesville, Andrew county, Missouri, will show that they were also lingering in our own State:

> I did not answer your letter requesting more specimens of the Colorado Grasshoppers with parasites, because they had left us, and now there is not one to be found. We had quite a stock of grasshopper eggs left us last Fall, which hatched, and in the timbered section and where the ground was smooth and hard, as "sod" or prairie that was plowed in the previous June, and not afterward plowed, they destroyed most of the wheat. But deep plowing in the Spring or late in Autumn puts them down, at least delayed them, and I think they never hatch.

---

* *Am. Entomologist* I, p. 74.

† W. L., in *Journal of Agr.*, St. Louis, Apr. 17, 1869.

Our own stock was bad enough, but on the 18th of June we received a large addition of flying ones from the South, which in some places took half of the corn, although they left on the 23d of June, staying less than five days. They came with a strong south wind, and while here the north wind blew, and if they were disturbed they would work a little South; but on the 23d, at 11 A. M., the south wind blew, and they rose simultaneously, and most of them left us; but our original stock not being able to fly, remained.

My experience is, that they like vegetables, in about the following order: Cabbage, turnips, dog fennel and burdock, tender apple and pear leaves, especially if close to the ground, as on young grafts. There are few nurserymen here who will set apple grafts if we have eggs in the ground. Then wheat, corn, oats—if hard, preferred; but they do most damage to oats by dropping the grain on the ground in cutting it off. They relish grapes about the same as oats; but the hydrocyanic acid in peach leaves is too much for them, and I have not seen one touched.

As I am glad to see you doing so good a work so well, if I can furnish you any information it will give me pleasure.

During this year, 1869, and the two following years, as will be seen from what is said further on under the head of "injuries by other non-migratory species," many of the common locusts of the country were unusually numerous and destructive; and the reports of their injuries must not be confounded with those of the Rocky Mountain species. Mr. Cyrus Thomas (*Am. Ent.* II, p. 82,) reports finding this species, in June, 1869, around St. Joseph, Mo. He says: "We arrived very early in the morning, and then they appeared to be somewhat torpid; yet when those in the grass were disturbed by the hogs, which were feeding upon them, they hopped about quite briskly. Swarms of them, as I was informed, had been flying over that section for a week previous to our arrival."

In 1870, what was probably this last species, swept down upon the country around Algona, Iowa, and in 1871 the progeny "hatched by myriads till after the first of June," and left about the first of July.* In parts of Utah and Colorado their injuries were also reported during this year.

In 1872 again they did some harm in parts of Kansas, for Mr. Albert Cooper, of Beloit, Kans., wrote me (September 1, 1872): "They came down upon us a few days ago, and are now eating up everything green." Mr. J. D. Putnam, who spent the Summer of 1872 in the Rocky Mountains, also wrote me "that *spretus* was quite numerous in the valley of the Troublesome River."

THE INVASION OF 1873.

During the years of 1873 and 1874, we have had a repetition, in a great measure, of the years 1866 and 1867. The invasion of 1873 was pretty general over a strip of country running from the northern parts of Colorado and southern parts of Wyoming, through Nebraska and Dakota, to the southwestern counties of Minnesota, and northwestern

* *Western Rural*, Chicago, September 26, 1874.


Map of North America, illustrating the country east of the Rocky Mountains subject to the ravages of the Rocky Mountain Locust — prepared by C. V. Riley.
Explanations.
Country subject to ravages.
Country ravaged in 1874, and which suffered most.
Invaded in 1874 but suffering less on account of being sparsely settled.
BRITISH AMERICA
CANADA
BRITISH COLUMBIA
MEXICO
TEXAS

[Fig. 31.]

counties of Iowa—the injury being most felt in the last two more thickly settled States. The insects poured in upon this country during the Summer and laid their eggs in all the more eastern portions reached. The cry of distress that went up from the afflicted people of Minnesota in the Fall of that year is still fresh in mind, and the pioneers of West Iowa had to suffer, in addition to the locust devastations, severe damage from a terrific tornado. Great ravages were also committed by locusts in Southern California during the same year.

THE INVASION OF 1874.

We now come to the Locust visitation of 1874, which will long be remembered as more disastrous, and as causing more distress and destitution than any of its predecessors. The calamity was national in its character, and the suffering in the ravaged districts would have been great, and death and famine the consequence, had it not been for the sympathy of the whole country and the energetic measures taken to relieve the afflicted people—a sympathy begetting a generosity which proved equal to the occasion, as it did in the case of the great Chicago fire, and which will ever redound to the glory of our free Republic, and of our Union.

From a very large number of data, culled from every available source, I have prepared the accompanying map, which will at a glance illustrate the country liable to be overrun by this Rocky Mountain scourge, and more especially the territory in the United States east of the mountains, visited in 1874. This last will be seen to embrace the entire States of Colorado, Nebraska and Kansas, and portions of Wyoming, Dakota, Minnesota, Iowa, Missouri, New Mexico, Indian Territory and Texas. The heavy, dark lines indicate the area over which the greatest injury was done; the dotted lines the area which suffered less, because more sparsely inhabited; and the fine lines the area which was more or less overrun by them. The insects were doubtless as numerous in the northwestern parts of Wyoming and Dakota, and in Montana, for, in fact, they breed there; but the country is for the most part so barren and so thinly settled that the reports are very meagre. The damage inflicted in this territory cannot fall far short of fifty millions dollars. That much of the damage resulted from the progeny of the swarms of 1873, which, hatching in the country already indicated, as invaded during that year, ravaged the crops of the country where they hatched, and eventually spread to the southeast, the records abundantly prove; but there was likewise a fresh invasion direct from the mountain region, which added to that of 1873, rendered the year 1874 so memorable.

In order to present a more intelligible account of this 1874 invasion, it will be best to treat it briefly in connection with each State and Territory which suffered from it.

From New Mexico, Texas and Indian Territory the reports that have come to my notice are meagre; yet they are sufficient, in connection with those published by the Department of Agriculture, to show that the territory indicated in my map was more or less visited. In Texas, they were more particularly injurious in Cooke, Belknap, Blanco, Blandera, DeWitt, Palo Pinto, Gillespie, Medina, Kendall, and San Sabo counties.

Missouri—Fully aware of the importance of a complete and reliable record of the Locust invasion of our own State, not only as a matter of history, but as a guide for the future, I have taken some pains to make the record as complete as possible. In order to do so, I sent out the following questions to correspondents in each county—the same, in fact, to whom I addressed the Chinch Bug circular:

1. Did the Locust appear at all in your locality or in your county the past Summer or Fall?

2. If so, give the exact date at which they first appeared, and, as near as may be, the direction from which they came, and the direction and force of the wind at the time.

3. State, as near as may be, the prevailing direction in which they flew or traveled, and whether the direction was much altered or influenced by the winds. Also, whether different swarms came at different times from different directions.

4. How long did they stay?

5. What plants or crops were most injured by them?

6. What plants or crops more particularly escaped their ravages?

7. Did the locusts lay eggs; and if so, what positions did they prefer, as sward, stubble, roadways, ploughed, high or low ground, etc.?

8. Were any of the eggs noticed to hatch during the protracted and mild Fall weather?

9. What are your recollections of former visitations, with reference to these questions? And what has been the damage resulting the succeeding year of such visitations, from the young hatched on the ground?

10. Give an estimate of the amount of damage caused by them in your county.

11. What means have been adopted to prevent their injuries or to destroy them?

12. *State more particularly, if locusts invaded your county, the precise eastern limit which they reached.*

Being firmly of the opinion that these insects would never do any serious damage east of a line drawn, at a rough estimate, along 17° west from Washington, and knowing that we could only judge of the

future by the past, I drew particular attention to the last question, as one not answerable from my own individual observation, as most of the others are. The replies to the above questions have been very full, for which fact I must again thank the gentlemen mentioned on pp. 51–2, *ante*. From these detailed reports, I have constructed the accompanying map* which indicates, 1st, the counties invaded in 1866, marked with a small cross (+); 2nd, those invaded in 1874, and the eastern limit reached, marked by ruled lines; 3d, the general direction from which the insects came, marked by the direction of the lines and by arrows. The answers to the different questions have been properly filed and arranged by counties, and will be preserved. They are too voluminous to publish, and it is sufficient here to give a summary of them, numbered to correspond with the questions.

1—This question is sufficiently answered on the map, from which it will be seen that 35 of our western counties were invaded, and that they reached farthest into the State in Benton and Pettis.

2—The general direction from which they came was from the northwest, the reports showing remarkable agreement in this respect. The greatest deviation from this course occurred in the more eastern or last counties visited, when the army became pretty well thinned out and demoralized, and flew about with less uniformity, being more governed by the wind. The dates at which they are reported from the different counties are interesting, and show that the insects advanced at an average rate of not more than three miles a day. That they travel at a far greater speed, every one who has witnessed their migrations is aware, and this low average rate is due to the fact that they fly only during the heat of the day and on certain days when the wind and weather are favorable, and to the further fact that the insects were no longer as vigorous and numerous as they had been in the country to the west. Another interesting fact is deducible from the returns, viz.: that the rate of advance was greater in the counties first invaded than those last reached—a fact indicating that the insects were getting more and more exhausted and less desirous of flight the farther east they came. They reached Holt county on the 8th of August, and all the counties on the same line, north and south, from Worth to McDonald, were reached during the latter part of the same month. They then continued to make short flights, and finally reached their extreme eastern limit toward the last of September.

3—The correspondents do not agree as to whether the wind has

* Where the map does not accompany this page it will be found in front of the Volume.

much influence on their flight; but the majority of the reports show that, as is the nature of the insect in other States, it only flew in dense swarms when the wind was from the northwest.

4—In most of the counties invaded, the locusts stayed till frost; i. e., from their first appearance till frost, swarms came and left, so that there were almost always some of them about. In some of the last counties invaded, they were observed for only a few days, and in all, their numbers diminished more and more through natural or unnatural death, until Jack Frost vetoed the hopping and kicking of the very last stragglers.

5—On account of the long continued drouth, and the ravages of the Chinch Bug, but little green food was left for the locusts to destroy. This, however, they took, showing no mercy. Corn was already too hard in most of the invaded counties to be damaged; but they stripped every green blade, and often the husks, when not already killed by the Chich Bug. Fall wheat and rye were eaten as fast as they came out of the ground, and the sowing of these grains was delayed on that account. Oats were taken, but as a rule only after wheat and rye. Clover and timothy shared the same fate, and, in fact all the grasses suffered. Most garden vegetables were destroyed. The tops of peanuts, buckwheat and beans were also to their taste, and they were particularly partial to hemp. Apple, pear and peach leaves were not amiss, and the green peaches were devoured, with the exception of the stones which were left hanging to the trees. Green apples were refused. Grapes were cut off from the vines, but not eaten. Tobacco was eaten in many instances, but they did not seem to enjoy it.

6—It is well known that these omnivorous creatures will devour almost anything when pushed from hunger; yet they have their likes and dislikes, and their conduct in Missouri, so far as regards the latter, as condensed from the reports, may be thus stated: Plants belonging to the Nightshade Family (*Solanaceæ*) generally escaped their ravages; the tops of potatoes and tomatoes were not eaten. Sweet potatoes, parsnips, castor-beans, butter-beans, carrots, celery and the tops of beets were not molested. They did no damage to broom-corn or sorghum. Tobacco was in most cases not eaten, and if eaten, it is reported as killing the locusts. Prairie grass, wild weeds and the leaves of most forest trees were left uninjured. Plants growing in wet places, or in the shade of trees, hills, etc., mostly escaped injury.

7—In most of the counties invaded, the insects are reported as having laid eggs; and in some localities the eggs were so numerous

as to whiten the surface wherever the ground was ploughed and they were exposed to the bleaching and cleansing effects of sun and rain. All the reports agree that low and moist ground was avoided.

8—In most counties, even in the northern ones, some of the earlier eggs hatched, especially those laid on hill-sides and other high ground exposed to the rays of the sun. The young hoppers attained a size of $\frac{1}{4}$ to $\frac{1}{2}$ of an inch, and were active during the middle of the day, even into December. These young hoppers disappear and seek Winter shelter; but it is doubtful whether many, if any, survive the Winter.

9—From the accounts received in answer to this question, it appears that in 1866 the locusts invaded pretty much the same counties, the farthest point reached to the eastward being the western portion of Benton county. As the map indicates, they reached somewhat further east in the northern part of the State than in 1874, but not so far in the southern counties, there being none recorded in Polk and Lawrence. Yet imaginary lines, indicating the average eastern limits of their advance in either year would run a little to the east of Warrensburg and Clinton in Johnson and Henry counties, and not more than a dozen miles apart. They came a month later in 1873 than in 1874, and were moving from about the first of September to the end of October. The direction of their flight and progress was precisely as the past year, i. e., from the northwest. They deposited large numbers of eggs which—for the most part—hatched in the Spring of 1867. The young hoppers did much damage in many localities in the Spring of this year, destroying the wheat, corn, grasses and vegetables by stripping off the leaves and leaving only the bare stalk standing. They also attacked the oats, biting the stalks and causing the grain to drop. They fed in large bodies, traveling together, and thus devastating the crops in strips and sections, leaving the intermediate fields untouched. But taking the reports of all the counties, comparatively little damage was done by these young hoppers—much less than was anticipated and seemingly warranted by the large numbers which hatched. They were attacked by parasites and diminished rapidly in numbers; and those which acquired wings, in the early part of July, generally left their place of birth, flying in all directions, but principally in the opposite direction to that in which they had come the previous Fall. They laid no eggs and were gradually lost sight of the latter part of the growing season.

10—The insects came too late last year to do very great injury. Everything green had about disappeared on account of the continued drouth and Chinch Bug. Wheat had been harvested and was there-

fore uninjured; corn was too dry and hard to suit their taste. The damage was chiefly done to the young wheat, which they made a clean sweep of in many localities—chiefly in the southern counties, where it was already sown. Pastures were injured so as to oblige very early feeding of stock. The principal damage was done to garden truck, and tender trees and shrubs; and compared to the injury of the Chinch Bug the aggregate damage by locusts was slight; while some of my correspondents considered these last a benefit on account of the abundant and fattening food they supplied to poultry and hogs.

11—With the exception of Fall plowing and collecting and feeding the insects to hogs, no remedies or attempts to destroy the pests are reported.

12—The answers to this question are summed up on the map.

KANSAS—While the injuries caused by the invasion of 1874 was comparitively slight in Missouri it was very great in Kansas. The locusts swept down upon that State in overwhelming hordes from the plains of Colorado on the west, and the fields of Nebraska on the north, in many instances clearing off all traces of vegetation in a few hours. The corn crop, not being as advanced as it was in our own State upon their advent, was ruined by them. I have newspaper and private reports of the appearance of the insects in all the counties, except Clarke, Comanche, Gove, Doniphan, Graham, Greenwood, Harper, Hodgeman, Kiowa, Neosho, Ness, Pratt, Sumner, Stafford, Trego and Wallace. Most of these counties are yet unorganized and do not exist, except upon the maps, the population being very limited and of a transient character. They were undoubtedly overrun like the rest, for Mr. Chas. S. Davis, of Junction City, who sent out postal-card queries over the State, informs me that he has reports from Doniphan, Comanche, Greenwood, Neosho and Sumner; and Mr. Alfred Gray, who has published full returns in his excellent report for 1874, as Secretary of the State Board of Agriculture, informs me that no county was free from visitation. He writes: "I have consulted with several reliable gentlemen concerning the appearance in the unorganized portion of the State, and find that the visitation was general. The representative from Ford county, Mr. Wright, says that south of his locality, in the Indian Territory, they appeared in immense clouds and would dip down at long intervals, and would as suddenly leave."

From the monthly returns published by Mr. Gray, it appears that 34 counties reported products enough to enable them to bridge over the Winter. Thirty counties reported 1,842 families, aggregating 9,154 persons reduced to destitution. The press of the country has been full

of accounts of the destitution and suffering which this visitation entailed on the people of our sister State, and the agents of relief societies have appealed with effect to the generosity of the people throughout the land. The accounts of the suffering and distress have been very conflicting, and the truth doubtless lies between the heart-rending, sensational compositions, and those which, prompted by State pride or real estate interest, go to the other extreme, and underate the real distress. The following from Mr. Gray's Report, undoubtedly gives a calm and truthful statement:

About the 25th of July one of those periodical, calamitous visitations to which the trans-Mississippi States are liable once in from eight to ten years, made its appearance in northern and northwestern Kansas—the Grasshopper or Locust. The air was filled and the fields and trees were completely covered with these voracious trespassers. At one time the total destruction of every green thing seemed imminent. Their course was in a southerly and southeasterly direction, and before the close of August the swarming hosts were enveloping the whole State. The visitation was so sudden that the people of the State became panic-stricken. In the western counties—where immigration for the last two years had been very heavy, and where the chief dependence of new settlers was corn, potatoes and garden vegetables—the calamity fell with terrible force. Starvation or emigration seemed inevitable unless aid should be furnished.

Again, Gov. Osborne says in his message to the Leglslature, convened in extra session by special proclamation to take action regarding the suffering:

Since issuing my proclamation convening the Legislature, an extensive correspondence has been carried on with the people, especially in the western counties, and every effort has been made by the executive office, as well as by the officers of the State Board of Agriculture, to obtain reliable statistics in regard to the condition of the people. The result of this inquiry shows that while Kansas as a State has an abundance of breadstuffs—much more than is needed to feed all her people—that that portion of the State which has been almost entirely populated during the past eighteen months, will suffer for want of the necessities of life unless provision is made for its relief.

From information now in my possession, it appears that the sections of the State for which relief should be provided by legislation are confined to the counties west of the sixth principal meridian. The counties most seriously affected, and for which the needed relief cannot be afforded by the local authorities, are Norton, Rooks, Ellis, Russell, Osborne, Phillips, Smith, McPherson, Rice, Barton, Reno, Barbour, Edwards and Pawnee; while the counties of Harvey, Jewell, Ellsworth, Sedgwick, Sumner, and possibly some others, may require more or less assistance. Of these, the greatest destitution seems to prevail in the extreme northwest, embracing Norton, Phillips, Rooks, Osborne and Smith counties, and the unorganized counties lying west, where immediate aid seems necessary.

At the special session, townships in the destitute counties were authorized to issue bonds to the amount of $50,000, but the act was subsequently declared unconstitutional by the Attorney-General, so that no bonds can be sold. This source of relief was therefore of no avail, and the regular Legislature was subsequently strongly petitioned and urged to afford relief by direct appropriation. Its action will ever redound to its discredit and to that of the State. After the whole country had, by sanction of its authorities, been canvassed and importuned for aid and relief, it was still evident as Spring approached that much assistance was needed in the frontier counties, and that, with-

out such assistance, the farmers in many counties would be unable to obtain seed to put in their crops or to carry on their legitimate farm operations. Yet in face of the constant appeals from thousands of sufferers, supplemented by two special messages from the Governor, in one of which he says: "I tremble to anticipate the judgment of mankind upon a commonwealth which, having encouraged appeals to the charity of the people of the whole country, steadfastly refuses to relieve a single want at the expense of its own treasury"—the Legislature finally adjourned without making any appropriation whatever. Yet there was abundant means in the treasury and the appropriations made for other purposes exceed half a million dollars. The ill repute which this neglect of her Legislature in the hour of need will bring upon the State will stick to her like the shirt of Nessus.

The following extracts from my private correspondence will indicate the periods at which the insects reached different parts of the State:

My interest in the cause in which you labor is my excuse for addressing you at this time. By virtue of your office you are public property, and the people of Kansas feel as if you belonged to us as well as Missouri. The main subject upon which I wish to write you is the "grasshoppers." Swarms of grasshoppers have been appearing in different parts of the State since the 15th of July. It is only within ten days that they have appeared in this immediate vicinity, and from what observation I have been able to make I cannot see that they have laid any eggs yet. They eat as voraciously as any I ever heard of. But for this fact, I would think they might be a brood hatched somewhere on the plains between here and the mountains, and that they will not breed. I understand that the only method of determining the difference between the barren brood hatched in the low lands and the swarms from the mountains is in the time they make their flight. In the Spring of 1869, when I came to this place, I watched the Spring brood hatch, and they all left as early as the middle of June. * * *—[Robert Milliken, Emporia, Lyon county, Kansas, Aug. 10, 1874.

I send you by mail a specimen of the devouring host. On Sunday evening, July 26th, they came down upon us by millions and soon cleaned our corn-fields and orchards, and then stripped the trees of their foliage. One week ago the bulk of these left, and we felt relieved of our fears that they would interfere with wheat sowing; but yesterday the sky was darkened with a new installment. There is no corn left even for seed in this county, and they are ruining the orchards. I send you some twigs. Often the trunk is girdled when they are 3 inches through. Nothing comes amiss to them, though they seem to have some preference for food. Box Elder does not seem to be palatable to them, or Black Walnut, still they will eat them, and large trees are stripped of leaves. Tobacco they seem to like, and you can see bunches big as your fist fighting and struggling to get a taste of some old quid that has been thrown in the road. To attempt to give any idea of the destruction of these plagues is useless, for the general public will not believe one-half the truth, but set us down as liars.—[H. L. Jones, Salina, Saline county, Kansas, Aug. 13, 1874.

I send you a few specimens of our "hoppers." They have destroyed the entire corn crops of Central and Western Kansas and left thousands of people in absolute destitution. They have tarried with us longer this year than usual, having been detained by adverse winds from making their usual annual southerly migration. They do not usually trouble us unless stopped in their course south by currents counter to the direction of their flight.—[N. B. Truland, Cawker City, Mitchell county, Kans., Aug. 11, 1874.

On Saturday the grasshoppers came down upon us here at Ottawa. They had been for some days to the north and east of us, and on Saturday a north wind brought them. They are in and upon everything, thick as bees in swarming time. I send you

some specimens. Are they *Caloptenus spretus?* I presume they are, without doubt. Yet I notice that many of them have the wing covers much less than ⅓ longer than the abdomen; but I believe all males have the little notch in the ventral segment. Will they probably remain here and deposit their eggs, or may we expect to see them move off? I have not seen any pairing yet.—[Wm. Wheeler, Ottawa, Franklin county, Kansas, Aug. 24, 1874.

As there prevails a belief that Kansas will suffer permanently from locust devastations; and as many people are deterred from migrating thither from fear of these insects, the following answer to an inquiry which I published in the New York *Tribune*, last October, may serve to measurably allay this fear.

Does the science of Entomology offer a solution to the Grasshopper question, that scourge of the trans-Missouri? I have made my arrangements to settle in Kansas or at some point in the "Far West" for the purpose of making a home, but do not relish the idea of being menaced by famine.—[Z. F. Hopkins, Jackson Co., Ill.

Just now the people of Kansas are, in many sections of that unfortunate State, greatly discouraged, and there is quite an exodus from her extensive and fertile plains, especially of the more recent settlers. Nor is the outlook encouraging, for the locusts very generally fell upon whatever in the way of food and forage had braved an unusual drouth. Yet much unnecessary alarm is manifested, and the desolation has been greatly magnified. The authorities have fully canvassed the position and find no need to ask assistance from sister States, and we may rest assured that while many of her farmers must suffer deprivation the coming Winter there will be nothing heard of the predicted famine. We should not forget that eight years ago Kansas suffered from such a locust invasion, yet the eight intervening years between the invasion of 1866 and that of the present year have been among the most propitious in her history.

The story of the Locust (*Caloptenus spretus*) is a long one, but without going into details, I can see no good reason why any one should hesitate to settle in Kansas on account of these insects. If I had any intention of settling in that State, I should choose this time of all others to do so: first, because so many of her citizens have become alarmed and are willing to sell fine homesteads at a great sacrifice; secondly, because, from the past history of these invasions, her people may reasonably expect exemption from them for a period of eight, ten, twelve or more years. Two invasions are not likely to succeed each other within two years in the same territory, and this is so well understood among the Mormons, who are apt to suffer from such devastating hosts, that they are in the habit of laying in a two years' supply of provisions—never fearing that there will be any need of a three years' supply. The people in Montana, Idaho and Nevada, expect to suffer from them about once in every seven years. The same argument, also, which would deter people from settling in Kansas would deter them from settling in the western part of Iowa, in Colorado, Nebraska, Texas, Minnesota, in short, in any of the country 500 to 550 miles east of the Rocky Mountains, from British America to Mexico; for all this vast extent of country is more or less subject to locust invasions. There are, indeed, few parts of the country not subject to periodic misfortune, either from meteorological or entomological excesses.

NEBRASKA.—Next to Kansas, this State suffered most, having been entirely overrun, as the following extract from a letter from Gov. R. W. Furnas will show: "The whole of our State, from a point, say thirty miles from the Missouri river west, has been more or less affected by 'grasshoppers.' The extreme western portion of the State was entirely devastated." They came in legions from the north and northwest, and the following extracts from correspondence will sufficiently indicate the time of appearance, which was during the last of July:

This region was visited by these grasshoppers on July 21st, and after a sojourn of ten days they departed, and with them went our corn crop for 1874. For ten long days the pests fed and fattened on our immense corn crops, and the last three or four days of their stay they deposited their eggs by the million all over the plowed ground and

new breaking. In some places a small fly, and also the common black ant, have been destroying the eggs. But for every one destroyed there are probably a thousand left. It was fortunate for us that they came no sooner, as the small grain here was all ripe and they did no damage to it.—[J. W. D., Fillmore, Neb., Aug. 5, 1874.

The locusts visited us about three weeks ago from the South, and stopped about ten or twelve days with us, doing a great deal of damage to corn, garden stuffs, etc.; but I think we shall get about a one-fourth crop of corn. Don't they like onions! You could see them stand upon their heads eating into these vegetables, and they left nothing but a skin outside. I noticed upon new breaking thousands of them pairing, but I think the bulk left before depositing eggs. The wheat crop and all small grain has been good; but I believe that up the Republican Valley, in the Southwest of the State, the new settlers will have a very hard Winter, on account of the locusts.—[J. W. C. White, Lincoln, Dodge county, Nebraska, August 14, 1874.

The locusts made their appearance here about the last of July, and left on the 7th of August. The wind was blowing from the Southwest at the time of their arrival, but I think there was an upper current of wind from the North, which carried the greater part of them past, not more than one in ten (apparently) coming down. The day after their arrival the wind blew from the Northeast, and at about 10 A. M. they began to leave, a few at a time, until about 12 A. M., when they arose in a cloud, and for some hours the air was full of them, some going and some coming. After they had been here for a few days, they gathered in great numbers on the new breaking for the purpose of breeding. The result of their visit to this part of Nebraska may be summed up as follows: Corn damaged to some extent; vegetables of all kinds, except potatoes, completely destroyed; apple and pear trees stripped of foliage, and the stems of the fruit eaten, so that most of it has fallen off. In some places they have eaten the peaches entirely, nothing being left on the tree but the pit.—[Wm. Dunn, Emerson, Otoe Co., Nebraska, August 20, 1874.

The locusts came more than a month ago, and after flying backward and forward for a couple of weeks, they settled down, apparently determined to stay.—[Jno. Byfield, Red Willow, Nebraska, August 21, 1874.

A "Nebraska Relief and Aid Society" was organized to provide for the destitution caused by the visitation, and through its exertions and through legislative aid all suffering was avoided. Gov. Furnas in his message to the Legislative Assembly gives the following summary of doings, after stating that the receipts by the Aid Society amounted, up to that time, to $68,080:

Our own State, like most other portions of the country at large, especially the West, has been afflicted the past season with short crops, by reason of drouth and grasshopper devastation. While the injury has been greater than from any and all causes heretofore in the history of the Territory and State, and cannot be otherwise than discouraging, particularly to the agriculturists, there is no disposition manifested to abandon any portion of the State * * * The visitation falls on the frontier counties with particular force. They must be aided or quit the country. Aided until another year's crop is produced, the foundation is laid for a prosperous future. Aside from a natural and general principle of humanity, other good and sufficient reasons exist why these people should be aided liberally and promptly. A very large proportion of those now on our extreme borders and in need, are ex-soldiers; those who responded promptly to their country's call in the late hour of peril. * * *

Our own people in the older portion of the State, not seriously affected, have contributed liberally and promptly, both in money and in kind. All the railroads in the State, as well as those leading into it, have, with commendable liberality, extended free transportation to the State Society in aid of those in need. Generals Ord, Brisbin, Dudley and Grover, of the regular army, have rendered incalculable aid and assistance, entering with a will and zeal into the work of relief. Through the instrumentality of General Ord, the Secretary of War ordered the issue of clothing to those in need. Many portions of the older States, hearing of our misfortunes, came nobly and promptly to the relief, and very liberally. The Nebraska Patrons of Husbandry have organized a State association for purposes of relief, and not only in this, but in other States, are accomplishing very much in the matter of aid. Through the efforts of our delegation

in Congress, acts for the relief of our people have passed that body. Extension of time has been given homesteaders, and a cash appropriation of $30,000 has been made with which to purchase seeds the coming Spring.

IOWA—As already stated in the chronological chapter, the Rocky Mountain Locust* invaded the northwestern counties of Iowa in the Summer of 1873, and much of the injury in 1874 resulted from their progeny. Fresh swarms came, however, in 1874, and the western counties of Algona, Calhoun, Cherokee, Clay, Dickinson, Emmett, Harrison, Humboldt, Jasper, Kossuth, Lyon, O'Brien, Osceola, Palo Alto, Pocahontas, Plymouth, Sioux, Winnebago and Woodbury, suffered more or less. East of the line indicated in my map, Iowa suffered nothing from these pests, and as the drouth was less severe than in other parts of the country, and the crops good, the distress in the ravaged counties was easily relieved.

A committee appointed to investigate the extent of devastation and of suffering in 1874, made the following cheering report to the Governor:

> We have heard, in the northwestern counties, of only a single report of eggs laid by the grasshoppers, and the pests left us too early for egg deposits; and we trust and believe they have left us for many years if not forever. The vast majority of those whom the benevolence of the people aided last year, and kept upon their farms and homesteads, have raised good crops, and with good farms and smiling faces they speak of the kind hearts who aided them in their hour of need. Now, this year, we want more aid, and must have it, to assist the settlers in Kossuth, Emmett and other sections of counties. It will take a large amount of supplies to preserve homes and make homes happy and comfortable there. Let the people with their magnificent crops and great hearts, pour out of all their abundance, and save the little farms of those who are striving to keep their little homesteads for themselves, their wives and children.

MINNESOTA—As in the case of Iowa, Minnesota was visited along her western border by these insects in 1873, and she had consequently to suffer from the young of that invasion in addition to the fresh swarms that overspread very much the same territory in 1874. The counties ravaged in 1873 were thinly settled, mostly by homesteaders with little means, and the consequent suffering was therefore very great. The value of the crops destroyed in 1873 was estimated officially:

Wheat	$2,000,000
Oats	528,000
Corn	256,000
Other crops	250,000
Total	$3,034,000

* My friend, J. M. Shaffer, in his Report for 1873, as Secretary of the State Agricultural Society, states (p. 25) that the insect was the common Red-legged species *(femur-rubrum)*; but specimens o this 1873 invasion, which he kindly sent me, are *spretus*, sure enough; and other specimens collected in 1874, and sent me by Professors Bessey and McAfee, of the Iowa Agricultural College, tell the same tale.

The young from the 1873 invasion destroyed most of the small grain and acquired wings, and began to leave the country in June. During the month of July, and more particularly during the first half, new clouds came from Dakota and British America and swept over very much the same counties overrun the previous year, reaching a little farther east. The clouds which came in 1874 are described as reaching 100 miles east and west and 200 miles north and south.

The Commissioner of Statistics, in his report for 1874, says that the locusts destroyed more than 50 per cent. of the crops that year in the counties of Brown, Clay, Cottonwood, Jackson, Lacquiparle, Lincoln, Lyon, Martin, Murray, Nobles, Redwood, Renville, Rock, Watonwan and Yellow Medicine; and a smaller percentage in Blue Earth, Chippewa, Faribault, Grant, Nicollet, Otter Tail, Sibley, Stevens, Swift and Wilkins.

Gov. C. K. Davis wrote to the Secretary of the War Department, about the middle of July, as follows:

> The locusts have devoured every kind of crop in the northwestern part of Minnesota. (They did the same thing last year in the same area). Many thousands are now suffering for food, and I am using every public and private source to send immediate supplies of food. This State is entitled to two years quota of arms, estimated at $8,160. I respectfully request to turn over to me, instead of arms, a quantity of rations, equivalent in value.

Colorado—The whole of Colorado east of the mountains was more or less overrun by this insect in 1874, and great damage was reported from Conejos, El Paso, Larimer, Weld, Cache a la Poudre, from Denver to Middle Park, and in the Ralston and Clear Creek regions. In the Platte Valley they did less harm. Mr. J. D. Putnam, one of my correspondents, wrote:

> The grasshoppers (*Caloptenus spretus*) have been quite destructive in this territory this year. They put in their first appearance at Valmont, Boulder county, on July 11, though I saw them on Gold Hill (in the Mts.) on July 8. The first lot remained several days and went off, but it was soon followed by another lot, and so they seemed to keep on coming. The wheat was nearly ready for harvest when they first came, consequently there is not the destitution among the farmers that there is in Nebraska.

Mr. O. A. Whittemore, Secretary of the Colorado Industrial Association, wrote:

> Our visitation this year came from the North and West. The first invasion crossed the mountains much to the north of us and coming down along the base of the mountains, and after doing much damage, leaving for the South. A late swarm came across the mountains directly west of us, and when leaving, seemed to be going South.

As this insect breeds in most of the western, mountainous part of Colorado, this State suffers more or less from its injuries every year. The insect is, in fact, the greatest pest to Colorado agriculture. Yet it is only when fresh swarms sweep through the mountain passes and canyons in darkening clouds, or when they bear down in multitudes

from the plains to the northwest as they did last year, that they are considered an unavoidable calamity. As a rule these fresh accretions come so early in the season as to pass on to the south or southwest without laying eggs; but very often they come late enough to lay their eggs—the progeny from which is much more to be dreaded than with us, because it is more healthful and vigorous and does much more damage.

DAKOTA.—This Territory was also overrun in 1873 as well as 1874. From the meagre data at my disposal, the settled portions were almost completely ravaged, and in the southeastern half scarcely a wheat-field escaped destruction. The late lamented M. L. Dunlap, in his "Rural" correspondence to the Chicago *Tribune*, gives the following picture of affairs in D. T.:

The Grasshopper has proven a burden, and the sound of the grinding is low, and the emigrant wagon with its white cover is traveling East instead of West. A letter before me from Dakota says: "If the grasshoppers scourge us another year, Dakota will become desolate, and be remanded to her ancient solitude. This is the fourth year of bad crops, and almost every farmer has a mortgage on his goods and chattels, to tide them over the past. Many have left, not to return, and others are to come back in the Spring. At the best, the outlook is blue with despair." This will turn back an army of laborers; for all those people, when they turn back, will need work, and this they should have, if possible. These people are returning from an immense belt of country, and the vanguard is already here, with the main army to follow. A little marauding insect, born of the mountains, has driven them back, and may hold the country for a long time. The pleasant dreams of the homesteader have been brought to a close, and unpleasant images have usurped the place. Even without the grasshoppers, pioneer life is a great struggle that none can fully appreciate until they have passed its exacting ordeal.

From Montana and Wyoming, where these insects are at home, and where, from the nature of the country, settlements are very sparse and agriculture scarcely has an existence, the reports of injury are meagre.

MANITOBA.—Their injuries in 1874 were severely felt in Manitoba. The shores of Manitoba Lake were reported as at one time strewn three feet thick with their dead carcasses, where they had been driven into the lake and cast ashore; while in the South, from Pembina to Stinking River, at Palestine, Boyne Settlement, Portage la Prairie, Rat Creek, Rockwood and Winnepeg, they were reported as utterly destroying oats, barley and other crops. From Mr. Geo. M. Dawson, of McGill College, Montreal, who, as Geologist and Naturalist of the N. A. Boundary Commission, has been collecting information as to the limits of the insect in this province, I learn that the usual eastern limit is formed by the edge of the wooded country, which crosses the forty-ninth parallel about lon. 96° 30′, and runs thence to the south end of Lake Winnepeg. A line drawn from Fort Garry to the forks of the Saskatchewan river; thence to Fort Edmonton, and thence to

the intersection of the Rocky Mountains and forty-ninth parallel; gives approximately the limit of the open prairie country. Over the whole area to the south of this line, the Locust is, he believes, frequently found in swarms. Mr. Dawson also informs me that they have been known to reach, in years past, a number of miles into the wooded country, as far east as the Lake of the Woods; or in other words, to about the same limit line that they reach in Missouri.

ITS FLIGHT AND RAVAGES.

[Fig. 32.]

A swarm of Locusts falling upon and devouring a wheat-field.

The voracity of these insects can hardly be imagined by those who have not witnessed them, in solid phalanx, falling upon a corn-field and converting, in a few hours, the green and promising acres into a desolate stretch of bare, spindling stalks and stubs. Covering each hill by hundreds; scrambling from row to row like a lot of young famished pigs let out to their trough; insignificant individually, but mighty collectively—they sweep clean a field quicker than would a whole herd of hungry steers. Imagine hundreds of square miles covered with such a ravenous horde, and you can get some realization of the picture presented last year in many parts of Kansas.

Their flight may be likened to an immense snow storm, extending from the ground to a height at which our visual organs perceive them only as minute, darting scintillations—leaving the imagination to picture them indefinite distances beyond. "When on the highest peaks of the snowy range, fourteen or fifteen thousand feet above the sea, I have seen them filling the air as much higher as they could be distinguished with a good field glass."* It is a vast cloud of animated specks, glittering against the sun. On the horizon they often appear as a dust tornado, riding up on the wind like an ominous hail storm, eddying and whirling about like the wild dead leaves in an Autumn storm, and finally sweeping up to and past you, with a power that is irresistible. They move mainly with the wind and when there is no wind they whirl about in the air like swarming bees. If a passing swarm suddenly meets with a change in the atmosphere, "such as the approach of a thunder-storm, or gale of wind, they come down precipitately, seeming to fold their wings, and fall by the force of gravity, thousands being killed by the fall, if it is upon stone or other hard surface."† In alighting, they circle in myriads about you, beating against everything animate or inanimate; driving into open doors and windows; heaping about your feet and around your buildings; their jaws constantly at work biting and testing all things in seeking what they can devour. In the midst of the incessant buzz and noise which such a flight produces; in face of the unavoidable destruction everywhere going on, one is bewildered and awed at the collective power of the ravaging host, which calls to mind so forcibly the plagues of Egypt.

The noise their myriad jaws make when engaged in their work of destruction, can be realized by any one who has "fought" a prairie fire, or heard the flames passing along before a brisk wind: the low crackling and rasping—the general effect of the two sounds, are very similar. Southy, in his Thalaba,‡ most graphically pictures this noise produced by the flight and approach of locusts:

> "Onward they come, a dark, continuous cloud
> Of congregated myriads numberless,
> The rushing of whose wings was as the sound
> Of a broad river headlong in its course
> Plunged from a mountain summit, or the roar
> Of a wild ocean in the Autumn storm,
> Shattering its billows on a shore of rocks!"

Nothing, however, can surpass the prophet Joel's account of the

* Wm. N. Byers, *Am. Entomologist*, I. p. 94.

† Wm. N. Byers, Hayden's Geol. Surv., 1870, p. 282.

‡ I., 169.

appearance and ravages of these insects. Omitting the figurative parts, it is accurate and graphic beyond measure:

"A day of darkness and of gloominess, a day of clouds and of thick darkness, as the morning spread upon the mountains; a great people and a strong; there hath not been ever the like, neither shall be any more after it, even to the years of many generations. A fire devoureth before them; and behind them a flame burneth; the land is as the garden of Eden before them, and behind them a desolate wilderness; yea, and nothing shall escape them. The appearance of them is as the appearance of horses; and as horsemen, so shall they run. Like the noise of chariots on the tops of mountains shall they leap, like the noise of a flame of fire that devoureth the stubble, as a strong people set in battle array. Before their face the people shall be much pained: all faces shall gather blackness. They shall run like mighty men; they shall climb the wall like men of war; and they shall march every one on his ways, and they shall not break their ranks. * * * They shall run to and fro in the city; they shall run upon the wall, they shall climb up upon the houses; they shall enter in at the windows like a thief."

Those who suffered from and witnessed the vast army that cast a blight over so large a portion of our Western country last year; or who passed by rail, during the better part of two days, through a perfect storm of these insects, which frequently impeded or stopped the train by their crushed bodies reducing the traction—will concede that Joel's picture is not overdrawn, and that, though written over 2,500 years ago, it might have been inspired from many parts of North America in the year 1874. The illustration (Fig. 32) which I give herewith, is reduced from one published last August in the *Scientific American*, and, though not accurate in structural detail, conveys a very good idea of the appearance of a swarm invading a wheat-field.

FOOD PLANTS.

The Rocky Mountain Locust may be said to be almost omnivorous. Scarcely anything comes amiss to the ravenous hosts when famished. They will feed upon the dry bark of trees or the dry lint of seasoned fence planks; and upon dry leaves, paper, cotton and woolen fabrics. They have been seen literally covering the backs of sheep, eating the wool; and whenever one of their own kind is weak or disabled, from cause whatsoever, they go for him or her with cannibalistic ferocity, and soon finish the struggling and kicking unfortunate. They do not refuse even dead animals, but have been seen feast-

ing on dead bats and birds. Few things, therefore, come amiss to them. Yet where food is abundant they are fastidious and much prefer acid, bitter or peppery food to that which is sweet. The following resume of my notes and observations may prove interesting: Vegetables and cereals are their main stay. Turnips, rutabagas, carrots, cabbage, kohlrabi and radishes are all devoured with avidity; beets and potatoes with less relish, though frequently nothing but a few stalk-stubs of the latter are left, and sometimes the tubers in the ground do not escape. Onions they are very partial to, seldom leaving anything but the outer rind. Of leguminous plants the pods are preferred to the leaves, which are often passed by. Cucurbitaceous plants also suffer most in the fruit. In the matter of tobacco their tastes are cultivated and they seem to relish an old quid or an old cigar more than the green leaf. Tomatoes and sweet potatoes are not touched so long as other food is to mouth.

Of cereals, corn is their favorite; if young and tender, everything is devoured to the ground; if older and drier, the stalks are mostly left; the silk is, however, the first part to go. All other cereals are to their taste, except sorghum and broom corn, which are often left untouched. They are fond of buckwheat and flax, but seldom touch castor beans.

Next to vegetables and cereals, they relish the leaves of fruit trees; they strip apple and sweet cherry trees, leaving nothing but the fruit hanging on the bare twigs. The leaves of the peach are generally left untouched, but the flesh of the unripe fruit is eaten to the stone. Pear trees, as Mr. Gale informs me, suffered less than any other kind of orchard tree at the Experimental farm at Manhattan, Kansas. The tender bark of twig and branch and trunk of all these trees is gnawed and girdled, and these girdled trees present a sad picture as one passes through the ravaged country during the subsequent Winter. Sour cherry, apricot and plum trees are less affected by them, while ripe fruit is seldom touched.

Of berries, strawberries and blackberries are devoured where raspberries are frequently unmolested. Flowering shrubs very generally suffer, and they are particularly fond of Rose and Lilac. Of herbaceous plants, Helianthus, Amaranthus and Xanthium are eaten with especial avidity. Grape vines suffer more from the girdling of the fruit stems than from defoliation. Forest and shade trees suffer in different degrees, and some, when young, are not unfrequently killed outright.

Last year, Honey Locust, Red Cedar, Box Elder, Osage Orange,

Elm and Oak, were either untouched or but little injured, while the following trees were preferred in the order of their naming: Ash, Willow, Cottonwood, Balm of Gilead, Silver-leaved and Lombardy poplars, Black Ash, Black Locust, Black Walnut, Hickory, Ailanthus, Maple, Sumach and Evergeens.

In every case they show a marked preference for plants that are unhealthy or wilted.

TIME OF APPEARANCE.

In endeavoring to deduce some general conclusions respecting the time of year that the 1874 swarms reached different parts of the country, great difficulty is experienced in sifting those accounts which refer to the progeny of the 1873 invasion, and the new comers which hatched within the insect's native range. Yet we shall find, as a rule, that the insects which hatch outside the native habitat—i. e., in Minnesota, Iowa, Missouri, and the larger part of Nebraska and Kansas—acquire wings and leave before the new swarms appear. In the more northerly of the States, as in Minnesota, the insects hatched on the ground acquire wings in June, and earlier in proportion as we go south, until in Texas they become fledged in April. The time of appearance of the new swarms is in inverse ratio; i. e., earlier in the more northern, later in the more southern States. Thus, while on the confines of the insect's native habitat, it is almost if not quite impossible to distinguish between the old and the new comers, in respect to the time of their acquiring wings; the difference in this respect becomes greater the farther south and east we go. The 1874 swarms appeared during June in Southern Dakota, during July in Colorado, Nebraska and Minnesota; during the latter part of this month in Iowa and Western Kansas. During August, they came into Southeast Kansas and Missouri; and by the middle of October they reached Dallas, in Texas.

One noticeable feature of the invasion was the greater rapidity with which the insects spread in the earlier part of the season, while in fullest vigor, and the reduction in the average rate of progress the farther east and south they went. The length of their stay depends much on circumstances. Early in the Summer, when they first began to pour down on the more fertile country, they seldom remained more than two or three days, whereas, later in the season, they stayed much longer. In speaking of the advent and departure of these insects, I use relative language only. The first comers, when—after having devoured everything palatable—they take wing away, almost always

leave a scattering rear-guard behind, and are generally followed by new swarms; and a country once visited presents for weeks the spectacle of the insects gradually rising in the air between the hours of 9 or 10 A. M. and 3 P. M., and being carried away by the wind, while others are constantly dropping.

ITS NATIVE HOME: IT CANNOT THRIVE IN THE MISSISSIPPI VALLEY, AND CAN NEVER REACH FAR INTO MISSOURI.

A full month before a single specimen of the Rocky Mountain Locust reached Missouri in 1874, I prophesied that it would come into our western counties too late to do any very serious damage, and that it would not reach beyond a given line.* To the many anxious correspondents who, fearing that the State was to be overrun, as Kansas was being overrun, wrote for my opinion and advice, I replied "Judging of the future by the past, the farmers of Missouri, east of the extreme western tier of counties need fear nothing from Locust invasions. They may plant their Fall grain without hesitation, and console themselves with the reflection that they are secure from the unwelcome visitants which occasionally make their way into the counties mentioned, and especially of the northwest corner of the State. The same holds true of the farmers of Illinois and of all the country east of a line drawn, at a rough estimate, along longitude 17° West from Washington."

The detailed account already given (p. 144) of the counties in Missouri invaded in 1874, will show how subsequent events bore out my prophesy, and how the insect reached just about the limit I had given it. But, it will be asked, "Upon what do you base this conclusion; and what security have we, that at some future time the country east of the line you have indicated may not be ravaged by these plagues from the mountains?" I answer that during the whole history of the species as I have attempted to trace it in the chronological account already given, the insect never has done any damage east of the line indicated, and there is no reason to suppose that it ever will do so for the future. There must of course be some limit to its flight, as no one would be foolish enough to argue that it could, in one season, fly to England or France, or even to the Atlantic ocean; and as its flight is by law limited to one season—for the term of life allotted to it is bounded by the Spring and Autumn frosts—so its power of flight is limited. And as the historical record proves that it never has done any dam-

* *St. Louis Globe*, July 20, 1874.

age east of the line indicated, it is but logical to infer that it never will. "Because an insect can fly 550 miles, it would be ridiculous to argue that, therefore, it can fly 700 miles. We might as well claim that because a man can jump a ditch twenty feet wide, therefore he can jump another ditch which is thirty feet wide; or because a man can easily carry a young calf upon his back, therefore, if he practices daily, he will be able to carry the same animal upon his back when it has grown to be a cow."*

My late friend, B. D. Walsh, who, from a number of data which he accumulated, first laid stress on this fact that the insect would in all likelihood never reach the Mississippi river, gives his reasons in the following concluding paragraph of his report as acting State Entomologist of Illinois:

Every man—except, perhaps, some crazy Millerite—believes firmly that, in all human probability, the sun will rise in Illinois every morning for hundreds of years to come. Yet he has no other kind of evidence to justify such a belief, than I have to justify the truth of my theory, namely, that in all human probability we shall never for hundreds of years to come, be afflicted with the Hateful Grasshopper in Illinois. Both the inorganic and organic worlds are governed by certain fixed laws; and whether it be a vast fiery globe of liquid larva, revolving slowly upon its axis in the midst of the attendant worlds that have been circling around it, each in its own peculiarly prescribed path, for indefinite ages, or whether it be some infinitesimally minute insect, winging its way from the alpine heights of the Rocky Mountains over the Desert Plains of the West; we have but to ascertain by what laws each of them is governed, in order to be able to predict, in the case of each of them, what is and what is not morally certain to happen in the future.

"But why," it will again be asked, "will not the young from the eggs laid along the eastern limit you have indicated, hatch and spread further to the eastward?" Here, again, historical record serves us, and there are, in addition, certain physical facts which help to answer the question.

There is some difference of opinion as to the precise natural habitat and breeding place of these insects, but the facts all indicate that it is by nature a denizen of high altitudes, breeding in the valleys, parks and plateaus of the Rocky Mountain region of Colorado, and especially of Montana, Wyoming and British America. Prof. Cyrus Thomas, who has had an excellent opportunity of studying it—through his connection with Hayden's geological survey of the Territories—reports it as occurring from Texas to British America and from the Mississippi (more correctly speaking the line I have indicated) westward to the Sierra Nevada range. But in all this vast extent of country, and especially in the more southern latitudes, there is every reason to believe that it breeds only on the higher mountain elevations, where the atmosphere is very dry and attenuated, and the soil

†Am. Ent. I, p. 75.

seldom, if ever, gets soaked with moisture. Prof. Thomas found it most numerous in all stages of growth along the higher valleys and canyons of Colorado, tracing it up above the perennial snows, where the insect must have hatched, as it was found in the adolescent stage. In crossing the mountains in Colorado it often gets chilled in passing the snows, and thus perishes in immense numbers, when bears delight to feast upon it.

My own belief is that the insect is at home in the higher altitudes of Utah, Idaho, Colorado, Wyoming, Montana, Northwest Dakota and British America. It breeds in all this region, but particularly on the vast hot and dry plains and plateaus of the last named Territories and on the plains west of the mountains; its range being bounded, perhaps, on the East by that of the Buffalo grass. Mr. Wm. N. Byers, of Denver, Colorado, shows that they hatch in immense quantities in the valleys of the three forks of the Missouri river and along the Yellow Stone, and how they move on from there, when fledged, in a southeast direction at about 10 miles per day. The swarms of 1867 were traced, as he states, from their hatching grounds in West Dakota and Montana, along the east flank of the Rocky Mountains, in the valleys and plains of the Black Hills, and between them and the main Rocky Mountain range.*

In all this immense stretch of country, as is well known, there are immense tracts of barren, almost desert land, while other tracts for hundreds of miles bear only a scanty vegetation, the short buffalo grass of the more fertile prairies giving way, now to a more luxurious vegetation along the water courses, now to the sage bush and a few cacti. Another physical peculiarity is found in the fact that while the Spring on these immense plains often opens as early, even away up into British America, as it does with us in the latitude of St. Louis, yet the vegetation is often dried and actually burned out before the first of July, so that not a green thing is to be found. Our Rocky Mountain Locust, therefore, hatching out in untold myriads in the hot sandy plains, five or six thousand feet above the sea level, will often perish in immense numbers if the scant vegetation of its native home dries up before it acquires wings; but if the season is propitious and the insect becomes fledged before its food supply is exhausted, the newly acquired wings prove its salvation. It may also become periodically so prodigiously multiplied in its native breeding place that, even in favorable seasons, everything green is devoured by the time it becomes winged.

* See Hayden's Geol. Survey of the Territories, 1870, pp. 282-3.

In either case, prompted by that most exigent law of hunger—spurred on for very life—it rises in immense clouds in the air to seek for fresh pastures where it may stay its ravenous appetite. Borne along by the prevailing winds that sweep over these immense treeless plains from the northwest, often at the rate of 50 or 60 miles an hour, the darkening locust clouds are soon carried into the more moist and fertile country to the southeast, where, with sharpened appetites, they fall upon the crops like a plague and a blight. Many of the more feeble or of the more recently fledged perish, no doubt, on the way; but the main army succeeds, with favorable wind, in bridging over the parched country which offers no nourishment. The hotter and drier the season, and the greater the extent of the drouth, the earlier will they be prompted to migrate, and the farther will they push on to the East and South.

The comparatively sudden change from the attenuated and dry atmosphere of five to eight thousand feet or more above the sea level, to the more humid and dense atmosphere of one thousand feet above that level, does not agree with them. The first generation hatched in this low country is unhealthy, and the few that attain maturity do not breed, but become intestate and go to the dogs. At least such is the case in our own State and in the whole of the Mississippi Valley proper. As we go West or Northwest and approach nearer and nearer the insect's native home, the power to propagate itself and become localized, becomes, of course, greater and greater, until at last we reach the country where it is found perpetually. Thus in the western parts of Kansas and Nebraska the progeny from the mountain swarms may multiply to the second or even third generation, and wing their way in more local and feeble bevies to the country east and south. Yet eventually they vanish from off the face of the earth, unless fortunate enough to be carried back by favorable winds to the high and dry country where they flourish. That they often instinctively seek to return to their native haunts is proven by the fact that they are often seen flying early in the season in a northwesterly direction.* As a rule, however, the winds which saved the first comers from starvation by bearing them away from their native home, keep them and

* Mr. Affleck, in the letter published in the Appendix, shows that they frequently take this direction in leaving Texas. Mr. S. T. Kelsey also writes me: In the Spring of 1874, I think late in May, they passed over the same country (between Hutchinson and Dodge counties in Kansas) going north, flying high as before, and none of them alighting so far as I could see or learn. They were observed by many persons besides myself, but as they did no harm there was little said about them. Mr. G. M. Dodge, of Glencoe, Dodge county, Neb., (*Prairie Farmer*, September 19, 1874,) also records their passing over that place in a northerly direction during the last of May—a date indicating that they must have been born in more Southern latitudes. See also Mr. Faulkner's letter, on page 141 of this Report.

their issue to the east and south, and thus, in the end, prove their destruction. For in the Mississippi Valley they are doomed, sooner or later.

There is nothing more certain than that the insect is not autochthonous in West Missouri, Kansas, Nebraska, Iowa, or even Minnesota, and that when forced to migrate from its native home, from the causes already mentioned, it no longer thrives in this country.

That the native home of the species is sub-Alpine, is proved by the fact of its abounding to such an extent in British America, and of its breeding in the higher mountain elevations, even up to the perennial snows. In fact, so high up does it breed that it often hatches so late in the season as to be overtaken by the cold of the succeeding Winter before acquiring growth, when of course it perishes without begetting. The truly Alpine country cannot, therefore, be its native home; and those found breeding at such a height must be the progeny of others which flew from the plains, either east or west of the mountains. Physical barriers on the high mountain summits put a limit to the insect's extension and propagation, just as they do in the Mississippi Valley.

Such are my opinions, based upon my own observations in Missouri, Kansas, Nebraska and Colorado; on those of a large number of correspondents, and especially upon the experience of men like Mr. Byers and Prof. Thomas, who have given the subject particular attention. In treating of the native home of the species, I have confined myself, as in all other cases in speaking of the insect, as much as possible, to the country east of the Rocky Mountain Range: I leave to others to trace its history beyond the mountains.

Beyond the boundary line indicated in my map (Fig. 32), they did not reach in 1874, and beyond that line I do not believe they will ever do any damage. Not that they may not extend to some extent beyond that line, in years to come, or that the young, hatching in 1875, will not push beyond it; for I have numerous records to show that they have occurred as far as the western point of Lake Superior, and that they have even reached the Mississippi in parts of Iowa: but in all such instances they appeared in scattering numbers only, and did no material damage. They were the last remnants of the mighty armies from the mountains, moving and blowing about, diseased, parasitised, intestate and wasting away.

Well is it for the people of Missouri; well is it for the people of the Mississippi Valley, generally, that this insect cannot go on multiplying indefinitely in their fertile fields! Else, did it go on multiply-

ing and thriving as the Colorado Potato-beetle has done, this whole valley would soon become a desert waste. A wise Providence has decreed that thus far it shall go, and no further.

It will surely be a source of satisfaction to the farmers east of the line indicated to feel assured against any future invasion by, or any serious injury from, an army of insects so prodigiously numerous as actually to obscure the light of the sun, and so ruinously destructive as to devour almost every green thing that grows!

WHAT INJURY MAY BE EXPECTED IN MISSOURI IN 1875?

The subject we have just been considering, brings us very naturally to the question propounded in the above heading. It is also a question of vital importance to the farmers in our western counties, and one that will be repeatedly asked this coming Spring; and as there prevails an erroneous impression that I have given it as my opinion that no damage can possibly result from the young hatching out in 1875, I will here repeat what I actually said on the subject last Autumn.

Setting aside possible but not probable injury from a new invasion, we may consider the probable injury that will result in 1875 from the progeny of those which came in 1874. The eggs which are deposited on southerly hill-sides often hatch before cold weather sets in, if the Fall is warm and protracted, while many hatch soon after the frost is out of the ground in the Spring. Yet the great bulk of them will not hatch till into April. That most of the eggs will hatch may be taken for granted unless we have very abnormal climatic conditions, and unprecedentedly wet and cold weather following a mild and thawing spell. The young issuing from these eggs will also, in all probability, do much damage, as they did in the Spring and Summer of 1867. But the actual damage cannot be foretold, as so much depends on circumstances. In 1867, in many counties of Kansas and Missouri, where the ground had been filled with eggs the previous Fall, little harm was done in the Spring—so small a percentage of the eggs came to anything and so unmercifully were the young destroyed by natural enemies. A severe frost kills the young after they have hatched, where a moderate frost does not affect them. In Missouri, if we have no weather that proves fatal to either eggs or young, considerable damage may be expected, but not as much as in the country to the West; for, as already stated, we received the more scattering remains of the vast army, and the eggs are neither as numerous, nor will they hatch as early in our territory as farther West. Following a rather mild February the March of '67 was a very severe one, the thermometer frequently indicating 18 degrees below zero, and accord-

ing to Mr. W. F. Goble, of Pleasant Ridge, Kansas, who wrote an excellent account of the insect,* this severe weather caused many of the eggs to perish; and he expresses the opinion that "judging from the voraciousness of those that did appear, I doubt not Kansas would have been made a perfect desert if all had lived."

If after the young hoppers hatch we have much cold wet weather, great numbers of them will congregate in sheltered places and perish before doing serious harm; but if, on the contrary, our Spring and early Summer prove dry and hot (which is hardly to be expected after the several dry seasons lately experienced) much damage will result from these young locusts, where no effort is made to prevent it. They will ruin most garden truck, do much injury to grain, and affect plants very much in the order previously indicated under the head of "Food-plants." They will become more and more injurious as they get older, until, in about two months from the time of hatching, or about the middle of June, they will begin to acquire wings, become restless, and in all probability leave the locality where they were born, either wending their way further South or returning in the direction whence their parents came the previous year. Some bevies may even pass to the eastward of the limit line reached in 1874, and fall upon some of the counties bordering that line; but they will lay no eggs, and will in time run their course and perish from debility, disease and parasites. In 1876 the Rocky Mountain Locust will scarcely be heard of within our borders; a few remnants from Kansas or Nebraska, or from the country to the southwest, may make their presence manifest, if the year should be exceptionally favorable to their development; but, whether delayed till 1876, or even till 1877, the last one will eventually vanish from Missouri soil, and their race will no more be known among us till—perhaps within the next six or eight years; perhaps not within the next twenty—a fresh swarm wings its way to our borders from the plains along the mountain regions. There is, therefore, no danger of their overrunning the State to the east of the limit line; nor of their doing permanent injury in the counties they now occupy.

RAVAGES OF MIGRATORY LOCUSTS IN THE ATLANTIC STATES.

We have already seen how the true Rocky Mountain Locust, which rarely reaches the Mississippi, may be distinguished from the Red-legged species, which often mixes with it and is common to a much larger extent of country, and reaches to the Atlantic. We have also

* Monthly Reports, Dept. Agr. 1867 p. 290.

seen that the ravages of migratory locusts between the Mississippi and the Rocky Mountains, and probably to the Pacific, are confined to the one, long-winged species, (*spretus*). "How then," will naturally be asked, "do you account for the ravages of migratory locusts in the Atlantic States, since swarms have been known in those States to fly over the country and commit sad havoc, and since you tell us that the Red-legged species is incapable of such migrations?" This question, which has never been properly answered, I will now proceed to elucidate.

First, as to migrating locusts doing great damage in some of the Eastern States during certain years, there can be no doubt of the fact. Harris, in his Treatise, gives an account extracted from the Travels of President Dwight, wherein they are recored as being most destructive in Vermont in 1797 and 1798, and as collecting in clouds, rising in the air and taking extensive flights—even covering persons employed in raising a church steeple, who, in such position, still saw the insects flying far above their heads. He also quotes from Williamson's History of Maine, that in 1749 and 1754 they were very numerous and voracious; that "in 1743 and 1756 they covered the whole country and threatened to devour everything green." Among the communications which I received last Fall was the following, descriptive of locust ravages in New Hampshire:

DEAR SIR: I see a note in the New York *Tribune* requesting those from the Locust regions to send you specimens of the variety. I send you a vial of them to-day by mail. They have been quite plenty in the Merrimack Valley on some farms. They have eaten all of our garden vegetables; in others they left us a small share. The small ones are the most plenty and the ones that have done the most mischief. I should like to know if they are of the same variety that infested the West.

Yours truly,

LEWIS COLBY.

BOSCAWEN, MERRIMACK CO., N. H., September 17, 1874.

The following account by Dr. U. T. True of the appearance of these insects in Cumberland county, Maine, in 1821, is so circumstantial that I give it in full, as quoted by Mr. S. H. Scudder:*

During the haying season the weather was dry and hot, and these hungry locusts stripped the leaves from the clover and herds-grass, leaving nothing but the naked stems. In consequence, the hay-crop was seriously diminished in value. So ravenous had they become that they would attack clover, eating it into shreds. Rake and pitchfork handles, made of white ash and worn to a glossy smoothness by use, would be found nibbled over by them if left within their reach.

As soon as the hay was cut and they had eaten every living thing, they removed to the adjacent crops of grain, completely stripping the leaves; climbing the naked stalks they would eat off the stems of wheat and rye just below the head, and leave them to drop to the ground. I well remember assisting in sweeping a large cord over the heads of wheat after dark, causing the insects to drop to the ground, where most of them would remain during the night. During harvest time it was my painful duty,

* Hayden's Report on the Geological Survey of Nebraska; and "The Distribution of Insects in New Hampshire," p. 375.

with a younger brother, to pick up the fallen wheat heads for threshing; they amounted to several bushels.

Their next attack was upon the Indian corn and potatoes. They stripped the leaves and ate out the silk from the corn, so that it was rare to harvest a full ear. Among forty or fifty bushels of corn spread out in the corn-room, not an ear could be found not mottled with detached kernels.

While these insects were more than usually abundant in the town generally, it was in the field I have described that they appeared in the greatest intensity. After they had stripped everything from the field, they began to emigrate in countless numbers. They crossed the highway and attacked the vegetable garden. I remember the curious appearance of a large, flourishing bed of red onions, whose tops they first literally ate up, and not content with that, devoured the interior of the bulbs, leaving the dry external covering in place. The provident care of my mother, who covered the bed with chaff from the stable floor, did not save them, while she was complimented the next year for so successfully sowing the garden down to grass. The leaves were stripped from the apple trees. They entered the house in swarms, reminding one of the locusts of Egypt, and, as we walked, they would rise in countless numbers and fly away in clouds.

As the nights grew cooler they collected on the spruce and hemlock stumps and log fences, completely covering them, eating the moss and decomposed surface of the wood, and leaving the surface clean and new. They would perch on the west side of a stump, where they could feel the warmth of the sun, and work around to the east side in the morning as the sun reappeared. The foot-paths in the fields were literally covered with their excrements.

During the latter part of August and the first of September, when the air was still dry, and for several days in succession a high wind prevailed from the northwest, the locusts frequently rose in the air to an immense hight. By looking up at the sky in the middle of a clear day, as nearly as possible in the direction of the sun, one may descry a locust at a great hight. These insects could thus be seen in swarms, appearing like so many thistle-blows, as they expanded their wings and were borne along toward the sea before the wind; myriads of them were drowned in Casco bay, and I remember hearing that they frequently dropped on the decks of coasting vessels. Cart loads of dead bodies remained in the fields, forming in spots a tolerable coating of manure.

Mr. J. S. Smith says that he has seen "hackmatack trees almost covered with them, and entirely stripped of their leaves."*

All these accounts agree in referring the injury to the common Red-legged Locust; but as I am fully persuaded that this species, as found in Illinois and Missouri, is incapable of any extended flight,† I could not help feeling that some other species had been confounded with it, and had played the part of migratory locust in the White Mountain regions of Maine and New Hampshire. It was with satisfaction therefore that, upon examining the locusts sent me by Mr Colby, I found them to belong to a new and different species, smaller than either the Rocky Mountain or the Red-legged species, but in structure and relative length of wing much more nearly resembling the former than the latter; in other words, its relative length of wing enables it to fly with almost the same facility as its Rocky Mountain congener. This species may be called the Atlantic Migratory Locust, and is described below, in comparison with its close allies:

CALOPTENUS ATLANIS N. sp.—Length to tip of abdomen 0.70—0.85 inch; to tip of closed wings 0.92—1.05 inches. At once distinguished from *femur-rubrum* by the

* Rep. Connecticut State Bd. of Agr. 1872, p. 363.

† I do not mean by this that it is incapable of rising in the air; but I am quite sure that as found in St. Louis county it is incapable of any such flights as *spretus* takes. In the higher parts of the country, whether east or west, the power of flight may be greater.

notched character of the anal abdominal joint in the male and by the shorter, less tapering cerci; also by the greater relative length of wings which extend, on an average, nearly one-third their length beyond the tip of the abdomen in the dried specimens; also by the larger and more distinct spots on the wings—in all which characters it much more closely resembles *spretus* than *femur-rubrum*. From *spretus*, again, it is at once distinguished by the smaller size, the more distinct separation of the dark mark running from the eyes on the prothorax and of the pale line from base of wings to hind thigh; also by the anal joint in the ♂, tapering more suddenly and by the two lobes forming the notch being less marked. From both species it is distinguished not only by its smaller size but by the deeper, more livid color of the dark parts, and the paler yellow of the light parts—the colors thus more strongly contrasting.

6 ♂'s, 7 ♀'s from New Hampshire. Just as the typical *femur-rubrum* is at once distinguished from the typical *spretus* by the characters indicated; so *Atlanis*, though structurally nearer to *spretus*, is distinguished from it at a glance by its much smaller size and darker, more marbled coloring. The contrast is all the greater in the living specimens, and I have seen no specimens of *spretus* that at all approach it in these respects.

Whether this is the *femur-rubrum* as defined by DeGeer or by Harris, it is almost impossible to decide, though Harris's figure of *femur-rubrum* better represents it than the true *femur-rubrum*, as subsequently defined by Thomas, and as found in Illinois and Missouri.

It has always been a question among orthopterists, as to whether *spretus* should really be considered specifically distinct from *femur-rubrum*, and Mr. Uhler has himself expressed to me his doubts as to the two being distinct. This indecision, which I myself very freely shared, may be attributed principally to the fact that the species just described (*Atlanis*) has very generally been mistaken for *femur-rubrum*, and that the accounts of this latter rising into the air in swarms have in reality had reference to the former species. The only reference to this longer-winged species, in the East, that I am acquainted with, is that by Dr. A. S. Packard, jr., whose reference to the occurrence of *spretus* in Maine and Massachusetts, as exhibited by specimens in the museum of the Peabody Academy of Science,* doubtless applies to *Atlanis*.

Whether these three insects, as here defined, are really distinct species, or only races of one and the same, is a question that each individual entomologist will decide for himself, according to his idea of what constitutes a species. As ordinary distinctions go, however, there can be no doubt as to their specific distinctness, notwithstanding my own conviction that they merge into each other through exceptional intermediate individuals. That they will cross with each other and produce fertile progeny, I have little doubt, and that *femur-rubrum* mixes more or less with the other two, is probable; yet *spretus* and *Atlanis* can never thus cross, for they are effectually sepa-

* *Am. Naturalist*, VIII., p. 502. Since the above was written, Dr. Packard has submitted a rather poor and discolored specimen to me, and it is, as I inferred, what I here call *Atlanis*.

rated by the Mississippi Valley—a fact proved alike by *spretus*' dying out on the limit line I have mapped, and by its perishing when artificially transported in the egg and hatched in the Atlantic States.*

It is in this, as it is in almost every other instance where large material from widely different parts of the country is examined; the lines which are easily drawn between species characterized from single individuals, break down, and continually remind us of the arbitrary nature of specific definitions, and of the fact that most of the species, as defined among lower animals and plants, have no real existence in nature. There are races of *femur-rubrum* which approach even the larger *differentialis* as much as they approach *spretus*. In short, without speculating on the common origin, in the past, of all these species—and, indeed, of all species composing present genera—we behold, in a broad sense, a short-winged species (*femur-rubrum*) common to the whole country between the Rocky Mountains and the Atlantic, giving way, in the higher altitudes alike of the Rocky Mountain and the White Mountain, and probably of the Alleghany regions, to a longer-winged one; and the reason why the western long-winged species is more disastrous than that of the East, is doubtless due to its larger size and to the larger extent of table land in which it breeds, as well as to the fact that the western climate is more subject to excessive drouths, which cut off the supply of nourishment at a time when the insects are acquiring wings, and thus oblige them to migrate—such conditions occurring much more rarely in the home of the eastern species. The future orthopterist, as he studies material from all parts of the country, will very likely write: *Caloptenus femur-rubrum*, DeGeer., var. *spretus* Thomas, var. *Atlanis* Riley; but the broad fact will remain that these three forms—call them races, varieties, species, or what we will—are separable, and that they each have their own peculiar habits and destiny.

INJURY FROM OTHER NON-MIGRATORY LOCUSTS.

Almost every year, in some part or other of the country, we hear reports of injury by locusts. In 1868, for instance, while the Rocky Mountain species was attracting attention, as I have already stated, (p. 137), in many parts of the West, other non-migratory species were extremely injurious in the Mississippi Valley, and in the Eastern States. In Ohio they appeared in countless myriads during that year, and at the meeting of the Cincinnati Wine Growers' Society it was stated that they invaded the vineyards, destroying entire rows, defoli-

* See an observation by Mr. S. S. Rathvon, of Lancaster, Pa., who concludes, from experiment, that the climate there is "unwholesome" to the species. (*Am. Entomologist*, II., p. 83.)

ating the vines and sucking out the juices of the berries. In the same year I saw them in countless millions in many parts of Illinois and Missouri. They actually stripped many corn-fields in these States, and had not the crops been unusually abundant, would have caused some suffering. They were very destructive to flower and vegetable gardens.

In 1869, they were, if anything, worse than in 1868. I remember that in the vicinity of St. Louis, in addition to their ordinary injuries, they stripped the tops of Norway Spruce, Balsam Fir and European Larch; took the blossoms off Lima beans; severed grape stems, and ate numerous holes into apples and peaches, thereby causing them to rot. They were indeed abundant all over Illinois, Missouri, Iowa and even Kentucky; but attracted no attention East.

In 1871 they were again very bad, especially East, as the following items will show:

The grasshoppers (locusts) have been more numerous and destructive this year in Maine than perhaps ever before. This was partly owing to the dry weather, and with the advent of the rainy season we hope their career will be somewhat checked. In this county they are thick, but in some of the central portions of the State they literally swarm, devouring nearly every green thing before them. They did much injury to the grass-fields, and now that is cut, they have betaken themselves to the cultivated crops. In some cases whole fields of corn and beans have been completely stripped. Even the potatoes have not been spared.—[*Country Gentleman*, Aug. 10, 1871, speaking of Insects in Maine.

Grasshoppers are reported to have very seriously injured the corn, grass and grain crops (and in some cases orchards and nurseries) of the counties of Androscoggin, Franklin, Knox, Kennebec, Lincoln, Oxford, Piscataquis, Penobscot, Waldo and Somerset, in Maine. So serious has been the damage that the subject was made a topic at the recent State Agricultural Convention in that State. In Androscoggin county, they injured pastures greatly and affected the condition and price of stock. Some grain-fields were protected by drawing a rope across the heads at sunset, thus brushing off the insects and preventing feeding. In Franklin county a field of twelve acres of sweet corn was only saved by keeping a man in it continually to drive out the grasshoppers. One man in York county stopped their passage to his fields by building a brush fence around them.—[*American Agriculturist*, 1871.

These pests (the locusts) have been numerous and destructive during the past month in some portions of the Eastern States. In Sagadahoc county, Maine, the crops and pastures were injured by them very much; also in Hancock county. In Franklin many fields of grain were cut to save the crops from them and for feeding. In Oxford oats were "eaten entirely down, as clean as though fed upon by sheep." In some portions of Plymouth county, Massachusetts, they are reported to have eaten everything green. In Caledonia county, Vermont, they have been very destructive. All through Windsor they have been "a terrible scourge." In Orleans they are reported abundant, and in Windham they have done "much injury to some of the crops." In Wayne county, Pennsylvania, also, they are reported to have done much damage.—[Monthly Report Dep. of Agr. for August and September, 1871.

In 1872 they were again injurious East:

The grasshoppers are making great havoc on the grass, grain and corn. For a space of about one and a half miles square they are destroying almost everything. Clover is trimmed up all but the head; oats-fields look like fields of rushes coming up to the hight of 16 to 18 inches without leaf or head. The leaves of wheat and their kernels are eaten out. These hoppers move back and forth two or three times a day, and whole sections are almost alive with them.—[*Mirror and Farmer*, (New Hampshire) August 10, 1872.

Even in 1874 much injury by them was reported in the Mississippi Valley and eastward, and a few extracts will suffice to indicate how numerous they often were:

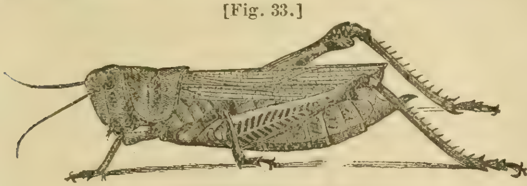
The grasshoppers destroyed four acres of my wheat last Fall; ate and destroyed my timothy twice; sowed the ground again this Spring, but as there are still plenty of hoppers there is not much hope for a stand.—[Letter extract from G. Pauls, Eureka, Mo., Nov. 10, 1874.

Some of our good friends in Suffolk county, Virginia, were unduly excited this Summer over the idea that the Western destructive grasshopper, *Caloptenus spretus* of Uhler, had found its way to the "sacred soil of Virginia." There was no denying the fact that myriads of grasshoppers were devouring nearly "every green thing," even settling on the trunks and limbs of trees, and gnawing the bark in a most unkind manner; and as it appeared to be something altogether foreign to the locality, of course, it must be the western pest. Specimens were forwarded to us, however, and a glance was sufficient to show us there was no need for alarm, as it was quite a common species in this part of the United States, and though rather too plentiful in this particular locality, would not spread or become the terror that its western distant relative has proved. The insect is known as the *Acridium Americanum*, and is of large size, often measuring over two and a half inches in length.—[C. R. Dodge, in *Rural Carolinian*, November, 1874.

In short, during hot and dry years, which are favorable to the multiplication of crickets and locusts, more or less injury is done, in all parts of the country by species indigenous to the different localities, but which in ordinary seasons do not attract any special attention. In every case, however, except in the mountain regions where the Eastern and the Western long-winged species are at home, or the country to which they migrate; the injury is caused by non-migrating species.

The principal depredator in such cases, in the Mississippi Valley, is the wide-spread Red-legged Locust, already described and illustrated, (p. 125) and so often confounded with the true migrating Rocky Mountain species. The next most injurious is the Differential Locust (*Caloptenus differentialis*, Walk., Fig. 33), a species at once distinguished, in the more typical specimens, from the preceding, not only by its larger size, but by its brighter yellow and green colors. The head and thorax are olive brown, and the front wings very much of the same color, and without other marks have a brownish shade at base, the hind wings being tinged with green; the hind thighs are bright yellow, especially below, with the four black marks as in *spretus*, and the hind shanks are yellow with black spines, and a black ring near the base. Next in injuriousness comes the Two-striped Locust (*Caloptenus bivittatus*, Say, Fig. 34,) also a larger species, of a dull, olive-

[Fig. 33.]



DIFFERENTIAL LOCUST.

green color, the hind thighs conspicuously yellow beneath, and with two yellow lines extending from above the eyes along each side of the thorax superiorly, and thence, more distinctly on the front wings, narrowing and approaching toward their tips, when closed. All these species belong to the same genus as our Rocky Mountain Locust, and, except in being unable to sustain flight agree with it in habit.

[Fig. 34.]

TWO-STRIPED LOCUST.

There are several locusts belonging to other genera which are common over large areas from the Atlantic to the Mississippi; and some of them, belonging to the genera *Acridium* and *Œdipoda* have relatively longer wings than the common Red-legged Locust, and consequently greater power of flight. Yet they are seldom as injurious as the short-winged Calopteni just enumerated, and the swarming of *Acridium Americanum* (our largest species), as described in the paragraph from the *Rural Carolinian* is quite exceptional.

ENEMIES AND PARASITES.

It is fortunate for man that, as in the case of most noxious insects, this locust is not without its numerous enemies. Chickens, turkeys and hogs devour immense quantities, and are happy during years of locust invasion, or whenever these insects abound. Prairie chickens and quails devour them with avidity, and even hunt for their eggs; swallows and blackbirds pursue them unrelentingly; the little snow birds devour great quantities of eggs when these are brought to the surface by the freezing and thawing of the ground; and the same may be said of almost all birds inhabiting the Western country in Winter; for in the crops of warblers, plovers, snipe and other birds killed by the telegraph wires in the vicinity of Lawrence, Kansas, my friend, G. F. Gaumer, found these eggs last Winter. The Shrike, or Butcher-bird, impales them on to thorns and other pointed substances; and a number of other birds, as well as reptiles, e. g. toads, frogs and snakes, feast upon them. But by far the most effective helps in weakening the vast armies of locusts, are the parasitic insects, albeit their work is perhaps less noticeable and less appreciated. Passing over the few, like certain species of Digger Wasps, belonging to the genus *Scolia*, which occasionally bury a few specimens as provision for their young; the ferocious Asilus-flies, which occasionally pounce upon a specimen and suck out its juices, and the omnivorous ant, which is

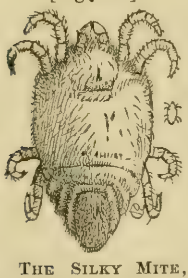
reported as feeding on the eggs and on the weak, sickly and disabled hoppers—it will be well to treat more fully of those parasitic species which render effective service to man in destroying this locust. These consist principally of two mites (class *Arachnida*,) which are external feeders, and two Dipterous flies belonging to the family *Muscidæ*, which are internal feeders.*

THE SILKY MITE (*Trombidium sericeum* Say, Fig. 35).—Last May, Prof. C. E. Bessey sent me a pale red mite with an account of its attacking the eggs of the Rocky Mountain Locust in northwestern Iowa, and numerous accounts were published of the efficient work of this little animal in destroying said eggs, wherever these had been deposited in Iowa and Minnesota. The following may be quoted as a sample:

> A discovery has been made of great interest. A small red bug, or spider, about the size of a small kernel of wheat, is found in great numbers, creeping into the holes to the grasshopper eggs and eating the contents of the eggs voraciously. Great numbers were found in the act of eating the eggs, with empty egg-shells in the same nest. The extent of the little friends is not limited, but they have been seen in many localities in different directions in this place. Mr. J. D. Johnston, Antrim, proved conclusively that these red bugs are making sure work among the eggs.—[*Madelia* (Minn.) *Times*.

This mite belongs to the genus *Trombidium*, only two N. A. species of which have been described, viz., the *scabrum* Say, and the *sericeum* Say. The descriptions in both instances are very brief, and it is difficult to say whether the species in question, and which is herewith figured (Fig. 35) belongs to either. It answers to *sericeum* however, so far as the description goes, and I prefer to so refer it rather than describe it as new. The specimens which I have examined have not been full grown, and the pale red color which they possessed would doubtless have intensified with age. Every European is familiar with the Scarlet Mite (*T. holosericeum*, *L*), which is common in the soil of gardens in Spring and preys upon young larvæ of various descriptions. In color, silkiness and habit it greatly resembles our species and may indeed be identical. All the species of this genus are highly colored and the *Trombidium tinctorium* found in Guinea and Surinam is employed as a dye.

[Fig. 35.]



THE SILKY MITE, natural size shown at side.

---

* The only other internal parasite affecting locusts in this country is a small, undescribed Chalcid-fly which Mr. Scudder refers to as having bred from the eggs of *Œdipoda Carolina* (Proc. Bost. Soc. Nat. Hist., XII, p. 99). He has kindly furnished me with female specimens. They are about 0.20 inch long, pitchy black, the head and thorax very deeply pitted and roughened, and the abdomen which is flattened and quite tapering also deeply marked with irregular, longitudinal depressions. The antennae have the scape as long as the flagellum, which is curved and enlarges to tip, which is suddenly docked. The scape, basal joint of flagellum and legs are honey-yellow; the wings hyaline.

THE LOCUST MITE (*Astoma gryllaria* LeBaron, Fig. 36).—This, though a smaller mite, is even a more efficient enemy than the preceding. Almost every one who has paid any attention to the locusts must have noticed that they are often more or less covered, especially around the base of the wings, with small red mites, seldom larger than the head of a pin. These mites have but six legs which, though easily visible when the animal first attaches itself, become more or less obsolete and invisible as it swells and enlarges, though a careful examination will generally reveal them at the anterior end of the body. The mite, therefore, more often presents to the ordinary observer a bright red, swollen, ovoid body, so immovable and firmly attached by its minute jaws, that those who are not aware of its nature might easily be led into believing it a natural growth or excrescence. In fact, it attacks the Locust precisely as the different wood-ticks attack man and the lower mammals.

[Fig. 36.]

THE LOCUST MITE, greatly enlarged.

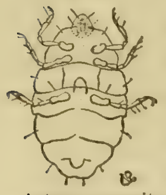
This mite belongs to the genus *Astoma*, briefly characterized by Latreille for a very similar mite (*Astoma parasiticum*) which affects the common House-fly and several other insects. The specific name *locustarum* was first proposed for it by B. D. Walsh,* but Dr. LeBaron afterwards gave it the name of *Atoma gryllaria*,† in connection with the following more detailed description:

They are of an oblong, oval form, moderately convex and having an uneven surface, produced by four shallow depressions on the upper side, the two larger near the middle, and the others behind them. The body has also two slight constrictions, giving it the appearance of being divided into three segments; but the impressions are superficial and only visible at the sides. The whole surface is finely striate, under the microscope, the striæ running in a waving transverse direction. The mouth-organs appear to be reduced to their minimum of development. The only part visible, externally, is a minute papilla, on each side of which are two bristles, the inner of which is stouter, tapering to an acute point, and curved inwards, or towards its fellow of the opposite side. They differ from the majority of Acarides in having but six legs, and these, being of but little use in so stationary a creature, are short and slender, projecting but little beyond the outline of the body. They are 6-jointed [in reality they are 5-jointed, the middle joint much the shortest, and the terminal joint longest.—C. V. R.], garnished with short stiff bristles, and terminate in two slender, curved hooks. The anterior and middle legs are closely approximate and situated near the anterior extremity of the body; the posterior are set a little nearer to each other, and a little in advance of the middle of the body, being inserted at the posterior part of the anterior division or lobe. Four hairs project from the posterior extremity of the body.

* *Practical Entomologist*, I, p. 126.

† LeBaron's 2nd Ills. Ent. Rep., 1872, p. 156. The author employs the term *Atoma*, which, though first so employed by Latreille, is corrected to *Astoma* in his "Genera Crustaceorum et Insectorum," I, p. 162, (1806).

[Fig. 37.]



Astoma parasite of the House-fly.

The dorsal figure on the opposite page (Fig. 36) exhibits the general appearance of the mite under a high magnifying power, and figure 37 which represents a ventral view of the mite found on our house-flies, and which is doubtless the *A. parasiticum* of Latreille, will better show the structure of the head and legs. During some seasons scarcely a fly can be caught that is not infested with a number of these blood-red mites, clinging tenaceously around the base of the wings.

As remarked in my last Report (p. 56) the genus *Astoma* and probably most other six-legged genera, are only larval or immature forms of some other mites; and this very Locust mite may be the larva of the Silky mite previously described, for ought we know to the contrary—there is so much to learn yet of the transformations of the Mites. Indeed, Hermann, and some other arachnologists have actually referred *Astoma* to *Trombidium*. In speaking of the Irritating Harvest Mite (*Leptus irritans* Riley, 6th Rep. p. 122) the so-called Jigger of the Mississippi Valley, and which is, in all probability, an immature form; I have stated my belief that its normal food must, apparently, consist of the juices of plants and that "the love of blood proves ruinous to those individuals who get a chance to indulge it; for unlike the true chigoe, the female of which deposits eggs in the wound she makes, these harvest mites have no object of the kind, and, when not killed at the hands of those they torment, they soon die—victims to their sanguinary appetite."* The same argument may, I think, be applied to the Locust Mite.

The Rocky Mountain Locust infested with this mite was sent to me in 1868 by Uriah Bruner, of Omaha, Nebr., and in 1869 by Clark Irvine and C. Twine, of Oregon, T. K. Faulkner, of Whitesville, and Jno. D. Dopf, of Rock Port, Mo.,—the latter gentleman stating that it was fast causing a diminution in the number of its victims. I have also received it from Minnesota and Kansas, and found it on several of our native locusts; while the following passage from an editorial account of the ravages of locusts in Kansas in 1869, which appeared in the *Prairie Farmer*, (Aug. 21, 1869,) is a sample of many newspaper accounts, and will show how efficient even a mite may be in killing.

The course of the locusts was brought to a sudden halt by the operation of some parasite, appearing in the shape of small red mites, which attach themselves to the body, under the wings, where they suck the carcass to a dry shell; the dead bodies of

* *Am. Naturalist*, Vol. VII, p. 19.

the grasshoppers almost covering some plants, where they have taken hold of a leaf or stalk, and clasped it, with a dead embrace; many others fall to the ground to die, too weak to rise again. In a half day's examination, where they were very thick, we failed to find more than two grasshoppers not so attacked, and this was not local, for a distance of thirty miles across the country they were found similarly affected.

THE ANONYMOUS TACHINA-FLY.—Our Locust, like so many other insects, is also subject to the attacks of certain two-winged flies much resembling the common House-fly, but larger. One is the very same Tachina-fly (*Tachina anonyma*) which I have bred from a number of other insects.* I first reared this fly from specimens of the Rocky Mountain Locust sent me by Jos. C. Shattuck, Vice Prest. of the Union Colony, Greeley, Col., who wrote, July 14, 1873, as follows of its work:

* * Also, I will say that the grasshoppers which a month since seriously threatened to devour every green thing, have met with a mortal foe and been slain by millions. (Don't think "millions" too large a word.) Very few have "taken to themselves wings and flown away," as heretofore, but lie dead in the fields they lately ravaged. A small fly pierces them and deposits an egg *while on the wing*, (or on the jump) and like Herod of old "they are eaten of worms and give up the ghost."

The following items undoubtedly refer to the same insect:

A Grasshopper-Exterminating Fly.—It seems that the grasshoppers that are so destructive to vegetation in many places in the central portion of the continent, are likely to find an enemy which threatens their rapid destruction. The Deer Lodge *Independent* says that a fly has made its appearance, closely resembling the common house-fly, but much larger, and of a gray, mottled color, which deposits its eggs under the wings of the Grasshopper. The egg is enclosed in a glutinous substance, which secures it in its position until the worm is matured [embryon developed.] It then penetrates the body of the Grasshopper, which speedily dies. The worm then burrows in the ground, and at the end of seventeen days comes forth a fly, ready to again commence the work of destruction. Mr. Wm. Walker, of Dempsey Creek, informs the *Independent* that twice during the past Summer the grasshoppers threatened to destroy his crops, but the flies killed them so rapidly that they did him but little damage. As the grasshoppers were killed before depositing their eggs, it is generally believed that this plague is ended in the Deer Lodge Valley.—[Published in several Montana papers in Summer of 1874.

A great many of the locusts seemed to be punctured on the back, and on pulling their heads off after death (many were found dead) from 1 to 3 ordinary looking maggots would be found. Many farmers fear it might be an introduction of a new plague. May not this gentleman with his little gimlet in time prove the destroyer of the hateful Locust?—[R. P. C. Wilson, Platte City, Mo., in private letter.

I saw a hopper kicking about as if he could hardly move; I pulled him to pieces and found that he contained a footless grub, half an inch in length. In a short time more were procured, placed in a covered tumbler, where, in a little more than two weeks, the grubs changed to Tachina flies, very much resembling the common house-flies, * * When we remember what an enormous number of eggs (fly-blows) a fly will lay and that each, in about a month, will be a perfect fly, it is seen that it would take but a few generations to clean out an army of grasshoppers—[Oscar J. Strong, Rolfe, Pocahontas county, Iowa, in *Western Farmer*, Feb., 1869.

Mr. Byers, in speaking of the locusts hatching in Colorado in 1865, (*loc. cit.*) says: "That upon attaining about half their full size, they were attacked by a fly, which, stinging them in the back between the root of the wings, deposited one or more eggs, which produced a

* See Repts. 4, p. 129 and 5, p. 133.

large white maggot. The worm subsisted upon the grasshopper, finally causing its death, when it cut its way out and entered the earth. In this way probably half were destroyed, often covering the ground, and filling the furrows in plowed fields with their carcasses. The remainder took to flight, moving southeast, when their wings were sufficiently developed, and we lost trace of them on the great Plains."

Mr. J. W. Crow, of Bigelow, Mo., in his correspondence with me, describes these maggots as infesting the "hoppers" in Holt county last Fall; and in 1869 I received the parasite from John P. Dopf, of Rock Port, Atchison county, and have bred it from the Differential Locust, figured further on, and from the Carolina Locust (*Œdipoda carolina*, L.) in St. Louis county.

Finally, Mr. S. E. Wilber, of Greely, Col., has published an account of what is evidently the same fly.* In this account, after showing how persistently the fly pursues the Locust—leaving it no rest, and so effectually weakening whole swarms as to render them harmless—he expresses the opinion that the constant importunities and annoyances of this fly are the cause of locust migrations. While, however, they may constitute a factor in the result, such a conclusion is too sweeping.

The Red-tailed Tachina-fly (Fig. 38) which is so useful in destroying the Army-worm, will serve to illustrate the species, and, indeed, differs scarcely at all except in having the tip of the abdomen red.

[Fig. 38.]

Red-tailed Tachina-fly.

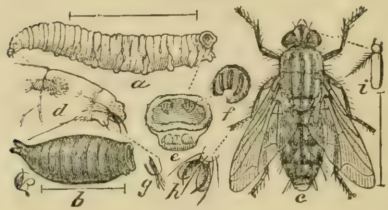
These Tachina-flies firmly fasten their eggs —which are oval, white and opaque and quite tough—to those parts of the body not easily reached by the jaws and legs of their victim, and thus prevent the egg from being detached. The slow-flying locusts are attacked while flying, and it is quite amusing to watch the frantic efforts which one of them, haunted by a Tachina-fly, will make to evade its enemy. The fly buzzes around, waiting her opportunity, and when the locust jumps or flies, darts at it and attempts to attach her egg under the wing or on the neck. The attempt frequently fails, but she perseveres until she usually accomplishes her object. With those locusts which fly readily, she has even greater difficulty; but though the locust tacks suddenly in all directions in its efforts to avoid her, she circles close around it and generally succeeds in accomplishing her purpose, either while the locust is yet on the wing, or, more often, just as it alights from a flight or a

* Popular Science Monthly, IV, p. 745.

hop. The young maggots hatching from these eggs eat into the body of the locust, and after rioting on the fatty parts of the body—leaving the more vital parts untouched—they issue and burrow in the ground, where they contract to brown egg-like pupæ, from which the fly issues either in the same season or not till the following Spring. A locust infested with this parasite is more languid than it otherwise would be; yet it seldom dies till the maggots have left. Often in pulling off the wings of such as were hopping about, the bodies have presented the appearance of a mere shell, filled with maggots; and so efficient is this parasite that the ground in parts of the western States is often covered with the Rocky Mountain Locust dead and dying from this cause.

THE COMMON FLESH-FLY (*Sarcophaga carnaria*, Linn.)—This fly, which is at once distinguished from the Tachina-fly by the style of the antenna being hairy (Fig. 39, *i*,) instead of smooth, is also a great enemy of the Rocky Mountain Locust, though I think it must be looked upon more as a scavenger than an active parasite, and that it is attracted more especially to those specimens which are feeble or already dead. I have received it among the Tachina parasites sent by Mr. Shattuck from Colorado, and from Professor C. E. Bessey, of Ames, Iowa, who bred it from the Differential Locust, and published the following description of its work:

[Fig. 39.]



SARCOPHAGA SARRACENIÆ.—*a*, larva, *b*, pupa, *c*, fly, the hair lines showing average natural lengths; *d*, enlarged head and first joint of larva, showing curved hooks, lower lip (*g*), and prothoracic spiracles; *e*, end of body of same, showing stigmata (*f*) and prolegs and vent; *h*, tarsal claws of fly with protecting pads; *i*, antenna of same—enlarged.

A COMMENDABLE FLY.—During the Summer I noticed that many of the large yellow grasshoppers (*Caloptenus differentialis*) were infested by the maggot of a species of fly very nearly resembling, if not identical with the common Flesh-fly (*Sarcophaga carinaria*). Many of the grasshoppers were almost completely eaten out when found, retaining just sufficient strength to hop feebly over the ground. I estimate that this particular species of grasshopper was diminished in numbers at least one-tenth, possibly one-eight, by these new friends. It is to be hoped that these new parasites will increase rapidly. Professor C. V. Riley informs me that the Migratory Locust (*Caloptenus spretus*) is also infested by a similar one; thus far, however, I have failed to detect any in the specimens collected in this vicinity.

I have also bred it from a number of our native Locusts whose carcasses—forsaken by the sarcophagous larvæ—may quite frequently be seen fastened to the upright stems of different plants, in the Fall of the year. I have also bred it from the common Carolina Mantis*,

* On the 18th of October, 1868, at South Pass, Ills., I found fastened to a tree, a large female Mantis, still alive, but with the abdomen hanging down, partially decomposed, and filled with Sarcophaga larvæ. These remained in the larva state in the ground till the next July, but gave forth the flies at the end of that month. The flies marked in my cabinet *Sarcophaga carnaria*, var. *mantivora*, differ in no respect from the common *carnaria*, except in size, seven not averaging more than 0.20 inch in length.

which it attacked while living; and have known it to infest the common Walking-stick (*Spectrum femoratum*). Indeed, the species is a most widely-spread and general scavenger, occurring in most civilized countries, and feeding as a rule on dead and decaying animal matter, and only exceptionally on living insects. By way of illustrating its transformations, I introduce a figure of the Sarracenia Flesh-fly (*Sarcophaga sarraceniæ* Riley) which feeds on the dead insects caught in those curious traps, the trumpet-leaves (*Sarracenia*), and which so closely resembles the common Flesh-fly in question, that it is probably only a variety.* These flies deposit living larvæ, which are distinguished from those of the Tachina-flies by being more concave and truncated at the posterior end. (See Fig. 39, *a*.) The Tachina larva is rounded posteriorly, with a small spiracular cavity, easily closed, and having a smooth rim: it contracts to a pupa which is quite uniformly rounded at each end. The Sarcophaga larva is more truncate behind, with fleshy warts on the rim of the spiracular cavity, and with a more tapering head: it contracts to a pupa, which is also truncate behind, and more tapering in front, where the prothoracic spiracles show as they never do in Tachina.

REMEDIES: HOW BEST TO PREVENT LOCUST INJURIES.

In considering this subject, it will be advisable to classify the agencies to be employed by the husbandman in protecting himself from Locust injuries. We shall then find that they may be classed under four heads: 1st, natural agencies; 2d, artificial means of destroying the eggs; 3d, such means of destroying the unfledged young; 4th, remedies against the mature and winged insects.

1st—The natural agencies, which I have just enumerated, should be encouraged as far as it is possible to encourage them; and it is very gratifying to know that the last Kansas Legislature had a sufficient appreciation of this matter to pass a law prohibiting the destruction of prairie chickens and quails.

2d—In the destruction of the eggs, man can accomplish most in his warfare with the insect. This fact has long been recognized in all European and Asiatic countries that suffer from locust depredations; and in France, Italy and several other countries, a reward of so much

*The flies bred from *Caloptenus* have the tip of the abdomen reddish, as in *Sarcophaga sarraceniæ*, and indeed are undistinguishable from the smaller specimens of this last. The larva differs, however, in having the surface more coarsely granulated, it being regularly and uniformly covered with minute papillæ; in the less conspicuous prothoracic spiracle; in the smaller but deeper anal cavity; and in the rim of this cavity having the twelve tubercles more conspicuous. The pupa also has the anal cavity smaller, more closed, but deeper; and the prothoracic spiracles less prominent. In these respects it agrees more closely with the typical *carnaria*, as described by Packard, and I have little doubt but all these differences are simply varietal.

per kilogram, or other measure, is always offered by the government whenever agriculturists suffer from invasions. When we consider the number of persons rendered destitute in Kansas, Minnesota and Nebraska, by the invasions of 1874, and the danger of immense damage in 1875, from the issue from the eggs which in many places fill the ground, it is surprising that the Legislatures of those States did not give the inhabitants of the ravaged counties at once the means of warding off misery and suffering, and guarding against future destruction, by offering a liberal price per bushel for locust eggs. Let us hope that, whenever such a calamity befalls those States again, something of this kind will be done.

Wherever the eggs were laid last Fall, I advised our farmers, where it was practicable, to plow deeply, so as to turn them under and bury them as far as possible. This destroys them either entirely or in great part, and if a few survive, the young hatch so late the next season, that their power for harm is much lessened; and the horses, also, in the ravaged districts, are in much better condition to plow in the Fall than they are likely to be in the following Spring. Care should be had not to bring the eggs turned under in Autum, to the surface again, by plowing the same land the following Spring; for, thus brought to the surface, the eggs would undoubtedly hatch.

When irrigation is practicable, as it is in some of the ravaged parts of Colorado, let the ground be thoroughly inundated for a few days, and the eggs will all lose vitality and rot. I have already shown that the eggs are laid, by preference, on the high and dry knolls and ridges, and never in low, moist ground; and experiments prove how soon they succumb to excess of moisture.

Just as excessive moisture is fatal to the eggs, so is excessive dryness, or direct exposure to the atmosphere, so that they receive alternately the direct rays of the sun and the rains and dews. Consequently, harrowing the ground where these eggs are laid, so as to break up the glutinous masses and expose the eggs to the influences mentioned, and to the more easy detection of birds, is to be recommended. Of course none of these measures, except the first, or collecting the eggs, are applicable on a large scale, except where the country is thickly settled and cultivated fields are abundant. Wherever hogs and cattle can be turned into fields where the eggs abound, most of these will be destroyed by the rooting and tramping.

3d—Next to the destruction of the eggs, the destruction of the young, wingless locusts, is most within man's power. Thus, much good can be accomplished by the use of a heavy roller, when the

young hoppers first hatch in Spring, or late in the Fall, as they exceptionally do when that season is prolonged and warm. In meadows and prairies they may be destroyed by fire started in a circle around them; or they may be driven into windrows of straw or hay, and then destroyed by fire; for when these young are traveling they can be driven almost as easily as a herd of sheep. Mr. N. C. Meeker, of Greeley, Col., states that in this way the farmers there manage to save 50 acres of grain at a cost not exceeding $20. Their course can also be governed by beating with brush until the advance guard is turned, when the balance follow the leaders. Wherever there are running ditches on a farm, the young can be driven into these and then caught and killed in sieves or coarse sacks. This method is quite commonly employed in those parts of the West where irrigating ditches and canals abound. In locust countries it is also a quite common practice to drive the young into a heap against any converging barrier, and then to destroy them by bagging or crushing.

The attempts to protect the plants by sundry applications, such as strong salt water, air-slacked lime, carbolic acid, etc., have proved unsatisfactory; and from the collective experience of a number of intelligent farmers in Colorado, which I made it a point of obtaining in 1873, I feel that nothing is to be hoped for from such substances. In 1868 and 1869, I sent two large cans of cresylic acid soap to Mr. Stephen Blanchard, of Oregon, Holt county, to be tested as a means of protecting his vegetables; but he in the end concluded that nothing would avail. Paris Green, as used for the Doryphora, will doubtless kill such locusts as partake of it; but its general use on all the plants which these omnivorous creatures relish, is out of the question. However, there is yet room here for experiment, though, considering that in all historical times, the resources of many nations have been employed against Locusts without furnishing anything that will protect plants on a large scale—little hope can be entertained of discovering such a substance. Turnips of which they are especially fond, kohlrabi, carrots, and the like, may be saved when the insects come late; by cutting off the tops and covering the roots with earth—the tops making excellent food for milch cows. The earth should be removed again as soon as possible to prevent the rotting of the roots.

Where the means already suggested cannot be employed, there are yet two methods of destroying these young, namely: by catching them in hand-nets, such as entomologists use, and as were described in my 5th Report; and crushing them with broad wooden shovels attached at an oblique angle to some kind of handle.

Finally, as Mr. Snyder well shows, in his letter which I publish in

the Appendix, most cultivated plants may be protected from the ravages of these young by good cultivation and a constant stirring of the soil. The young have an antipathy to a lose and friable surface, which incommodes them and hinders their progress; and they will always leave such a surface for one more hard and firm. I say, therefore, to those in the districts where the locusts hatch out: get your crops in early; employ some one or all of the means here indicated; get your neighbors to do the same; but by all means cultivate thoroughly. Let the local granges take the matter in hand, and by resolution oblige united action among themselves, at least, by establishing a fine or some other penalty, to be paid by any recusant and neglectful members. If the means here enumerated are adopted in concert over the more thickly settled portions of the threatened country, as in our own western counties, prospective injury may be averted, and the enemy be rendered comparatively harmless until the danger is passed. Two or three month's energetic work will suffice. Determination perseverence and united action must be the watch-words. With these, the people in the stricken counties will accomplish more good than would have been accomplished by the $50,000 which the Legislature refused them last winter. In the less thickly settled parts no human agency is likely to affect the pest, and we can only hope that Providence, by the different natural agencies known to be fatal to it, may act where man is impotent.

4th—The destruction of the winged insects when they swoop down upon a country in prodigious swarms, is impossible. Man is powerless before the mighty host. Special plants, or small tracts of vegetation may be saved by perseveringly driving the insects off, or keeping them off by means of smudges, as the locusts avoid smoke. Great numbers may be caught and destroyed by bagging and crushing as recommended for the new-fledged; but as a rule the vast swarms from the west will have everything their own way. Mr. Kelsey succeeded in saving many of his young forest trees in Kansas by perseveringly smudging and smoking them.

He gives his experience in the following words in the *Kansas Farmer*, Aug. 26, 1874:

At first we tried building fires on the ground, but it was not successful. The smoke would not go where we wanted it to. We then tried taking a bunch of hay and holding it between sticks, would fire it, and then, passing through the field on the windward side, would hold it so that the smoke would strike the grasshoppers. We would soon have a cloud of hoppers on the wing, and by following it up would, in a short time, clear the field. We have thus far saved everything that was not destroyed when we commenced fighting them, and while I do not give this as an infallible remedy, not having tried it sufficiently, yet it does seem to me, from what I have seen of it, that one good active man who would attend right to it could protect a twenty acre field or a large orchard. But to be successful one must attend right to the business.

Smoke and scare, and keep it up until the hoppers leave, and if they attempt to come again, be after them with your smoke. Give them no peace from morning till night.

Sweetened water will measurably protect plants when the insects are not too ravenous. The same is true of old hay which was extensively used to cover and protect favorite garden plants. One of the few effectual means employed against the winged insects last year in grain fields was to "rope" the fields. This was done by hitching each end of a long rope to a horse and then causing it to be dragged over the grain, thus disturbing the insects and causing them either to fall to the ground or fly off. If continued the locusts get disgusted and leave. While this, and all other methods, are futile as against the vast swarms which continue to drop down upon a country for days, it will prove useful against local swarms when they become fledged, or small swarms which may suddenly alight in restricted localities. They should be driven off as much as possible towards evening, because they then use their wings reluctantly, and they do great injury during the night.

SUGGESTIONS THAT MAY BE OF SERVICE.

In addition to the foregoing remedial and preventive measures to be taken in dealing with locusts, a few other suggestions occur which may be of advantage. The plants that can be grown which are unmolested by the pests and which will not, in all likelihood, suffer, have already been enumerated: those which are cultivated are principally peas and other leguminous species, castor beans, sorghum, broom-corn, tomatoes, sweet potatoes, etc. The locusts, are, as already stated, particularly fond of tansy, cocklebur, and Amaranthus, and especially of turnips: why, therefore, should these not be sown around a grain-field, and periodically sprinkled with Paris Green water, so as to kill large numbers of the young insects? These last will also congregate on timothy in preference to other grasses or grain, and a strip of timothy around a corn or wheat-field, to be poisoned in the same way, might save the latter. It is also currently supposed that the common larkspur (*Delphinium*) is poisonous to these insects, but how much truth there is in the statement I am unable to tell. In going through an oats-field the winged insects drop a great deal of the grain, which, when ripe enough, might at once be harrowed in so as to furnish a good growth of fodder that can be cut and cured for Winter use. The lesson of 1873 and 1874 should also not go unheeded. The former year was one of plenty, and corn was so cheap and abundant that it was burned for fuel in many sections where in 1874 there were empty cribs and the farmers wished they had been more provident.

Nothing, however, will so surely insure those States subject to them, against the ravages of this insect, as irrigation. With water at command, the farmer in all this locust area is measurably master of his two greatest insect plagues, and full master of the young locusts; and if there were no other reasons to be urged in its favor, these are sufficient to warrant those States included in said area, in using all means in their power in having schemes for irrigation perfected and carried out as far as the topography, soil, and other peculiarities of the country will admit.

Finally, in cases where, as in some parts of Kansas and Nebraska last Autumn, famine stares the people in the face, why should not these insects be made use of as food? Though the question will very generally cause the reader to smile, and the idea will seem repugnant enough to the tastes of most, I ask it in all seriousness. It is to be hoped that none of the people of this grand and productive country will ever be reduced to the diet of John the Baptist; but it should not be forgotten that the locusts may be made use of as food; that they are quite nutritious, and are, indeed, highly esteemed by many peoples. I do not intend in this connection to write an essay on edible insects, though a very curious and startling one might be written on the subject; but I wish to insist on the fact that in many parts of Asia and Africa subject to locust plagues, these insects form one of the most common articles of food. Our own Snake and Digger Indians industriously collect them and store them for future use. Deprived of wings and legs, they are esteemed a great delicacy fried in oil, or they are formed into cakes and dried in the sun—sometimes pounded into flour, with which a kind of bread is made.

Love or dislike of certain animals for food are very much matters of habit, or fashion; for we esteem many things to-day which our forefathers either considered poisonous or repulsive. There is nothing very attractive about such cold-blooded animals as turtles, frogs, oysters, clams, crabs, lobsters, prawns, periwinkles, snails, shrimps, mussels, quahaughs or scallops, until we have become accustomed to them; and what is there about a dish of locusts, well served up, more repulsive than a lot of shrimps; they feed on green vegetation and are more cleanly than pigs or chickens. Who can doubt but that the French during the late investment of Paris would have looked upon a swarm of these locusts as a manna-like blessing from heaven, and would have much preferred them to stewed rat? And why should the people of the West, when rendered destitute and foodless by these insects, not make the best of the circumstances, and guard against famine, by collecting, roasting and grinding them to flour? Surely,

with modern cookery they can improve on the Digger Indians in making a locust dish that shall be attractive and palatable even to those not predisposed from sharpened appetites, to judge favorably; and in any event it would pay under such circumstances to roast and preserve them as food for poultry and hogs.

NOMENCLATURE.

Regarding the popular name of our insect there is great lack of uniformity in the terms by which it is designated, and many of the readers of this Report who have been accustomed to hearing these insects very generally called "grasshoppers," will doubtless wonder why I have not followed common usage. The term "Grasshopper" is very generally employed for these insects in America, but should be abandoned for that of "Locust," which is applied to similar species in all other parts of the world, the "locusts" of Scripture being very closely allied species. As I have already said, (6th Rep. p. 153, note):

It is to be regretted that American entomolgical writers do not more strictly follow Harris in conforming to the English custom of calling these insects—with short antennæ and stridulating by means of the stout hind legs—by the popular term of "locusts," which is in the keeping with ancient usage. The term "grasshopper" would then be confined to the long-horned and long-legged, green group, stridulating solely with the wings, in which the species are more solitary and never congregate in swarms, and in which the female is invariably provided with a sword or cimiter-shaped ovipositor; while the term Katydid could be used to designate the few larger, tree-inhabiting species of the group, so designated by Harris. Where the habit of calling the Cicada "Locust," and the "Locust" of ancient usage "Grasshopper," is as inveterate as in this country, it is not easy to change it; but it seems to me that the change is desirable, and if popular authors would only continue the example of Harris, the change would come about with the greater dissemination of entomological information.

Almost every entomological author has been under the necessity, at one time or another, of insisting that the "Grasshopper" of this country is the "Locust" of Europe and of antiquity; or of endeavoring to clear up the confusion which results from the popular application of this last term to the Periodical Cicada or Harvest-fly—an insect (Fig. 40) which dwells, in its early life, under ground, and feeds by sucking the sap of trees, and which is no more capable, like the true locust, of devastating our grain-fields than a calf is of killing and devouring our sheep. Yet the ceaseless preaching about the popular misapplication of these terms in America will avail nothing so long as the popular error is encouraged by the preachers themselves adopting the misapplication. The popular names of a country should be respected as much as possible, especially for objects peculiar to the country, and I would be the last to try and change them

[Fig. 40.]

CICADA, or miscalled locust: with one wing removed, so as to show the beak and vipositor.

for trivial reasons; but when, as in this instance, the name used for centuries in the older countries, and become familiar as household words through the widely disseminated Scriptures, is substituted by a new one, and transferred to an entirely different insect, there is no excuse for perpetuating the popular error.

We may talk of *shipping* a car-load, and of the *sun's rising*, from now till doomsday; and, though, to the intelligent and hypercritical mind the expressions will ever savor of incorrectness; no one is foolish enough to try and reform them, because they are universal, wherever the English language is spoken. Change in universal and long established customs is neither possible, as a rule, nor advisable; and it is doubtful if any reform could be brought about in our present Gregorian calendar, for instance, even if the advantage of regulating the divisions of the year by the astronomical conditions of the earth's orbit could be fully established. But in a case like that between the use of the terms LOCUST and GRASSHOPPER, the former, as applied to our Rocky Mountain plague and its allies, has every claim to favor, not only because of having been longer used, and of its now being more universally used than the latter; but because it has a definite meaning and agrees with the old systematic name of the family to which the species belongs; while the term "grasshopper" is most loosely applied to almost every field insect that hops. The term locust is, in fact, supposed to be derived from the Latin words *locus ustus,* which mean a burnt place, and have reference to the desolation, as if by fire, which these insects cause.

The trivial terms "Colorado," "Red-legged," and "Hateful" have been applied to the species by various writers; but the name "Rocky Mountain Locust," which I have employed, is expressive of the insect's habitat and least open to objection.

Regarding the scientific name of our insect, it is only necessary to add in addition to what has already been said, that it belongs to the modern genus *Melanoplus* of Stäl; but just as this author's subdivisions of certain genera in Coleoptera are not accepted or recognized by many of our best coleopterists, so *Melanoplus* is not considered as of generic value by some of our best orthopterists; for which reason I have used the better known and well established genus *Caloptenus.* The specific name *spretus* (meaning despised) indicates that, as a species, it was so long overlooked by entomologists, and confounded with *femur-rubrum.*

PRAIRIE FIRES vs. THE ROCKY MOUNTAIN LOCUST.

The notion has got into the heads of a good many people, that there is some connection between prairie fires and the Locust visitations. Having already discussed the subject in the columns of the New York *Tribune*, I will here repeat what I there said:

The *Kansas Farmer* for September 23d last, contained a lengthy and hortatory article on the effects of prairie fires. The burden of the article was to prove that all misfortune that had befallen the fair State of Kansas was in one way or another attributable to the custom of burning over the prairies. In the words of the writer: "The unbroken succession of curses that have afflicted this and neighboring counties * * all spring from the one first grand cause, the burning of the prairie grasses," and he then goes on to demonstrate, as he believes, that burning the grasses from the face of the earth had been the one great cause of drouth, hot winds, locusts and short crops. The drouth, hot winds, and grasshopper raids of 1860 are attributed to the universal burning of grass in 1859. The short crops of 1864, the locust invasion of 1866, and the bad years of '68 and '70 similarly find their explanation in said article, in the burning of the grass, now attributed to Indians desirous of driving their buffalo herds westward, and of putting between them and the troublesome frontier hunters a "wide, black and impassable waste"—now to the Texan cattle traders who, on their way home from Abeline, fired the prairies on all sides, so that it was burned off "from the North pole to the Gulf of Mexico." The disasters of 1874 were confessedly not preceded by such general conflagrations, but the reduced snow-fall in the mountains is made responsible for that portion of the 1874 disaster which prairie fires did not produce.

The writer then goes on to state some well-known principles of radiation and to explain that all simoons or hot scorching winds have their origin in desert countries, and that "it matters not whether the country is an original desert or whether it is made so by the action of our Western prairie fires. For all present purposes the two are reduced to a common level, and produce a common result—drouth, hot winds, and locusts." Having thus traced the cause of drouth to prairie fires, the article goes on to show how the locusts are a consequence of drouth. The author first asserts that the State has never been "visited by these destructive locusts except during seasons of drouth and hot winds," basing his assertion partly on the fact that Kansas never suffered from these insects during fruitful years. I cannot say how well founded is the assertion, but the latter statement is a simple truism not necessarily proving the assertion. When we remember also the number of drouthy years that have not been succeeded by locust invasions the assertion loses much of its force. As a single instance, let us recall the unprecedented drouth of 1871. This was not preceded, that I am aware of, by any unusual number of prairie fires; but it *was* the indirect cause of most remarkable and destructive conflagrations all over the Western country during the Fall of the same year. Nor was it succeeded by locust invasions, as it should have been were the position of the writer in the *Kansas Farmer* well taken.

The reason given why the locusts can only come in drouthy seasons, is, that they cannot fly in a moist atmosphere, and the facts that they do not readily fly early in the morning, and that the farther east you go, or, in other words, the more moist the atmosphere becomes, the insects diminish in number and consequent power for harm. In further support of this view, it is asserted that at Kansas City, "where two rivers connect with their wide belts of timber shade, with an old settled country surrounding them, so that prairie fires cannot exist, we find no locusts." The author having proved, in this manner, and to his own satisfaction, the connection between burning grass and locusts, closes with a graphic picture of what might have been had misfortune not frowned upon the people, and an earnest appeal to the former—not in one township or section, but over the whole State—to cease burning the prairie, as the only radical cure for all these evils. Now, if he has reasoned well, it is of the utmost importance for the people of Kansas to follow his advice, and the subject is, consequently, well worth a little attention. I will, therefore, give my reasons for believing that while some partial truths have been stated in his thesis, the general conclusions are false and misleading:

1.—It is by no means proved that the simoons which occasionally sweep over our Western States and Territories have their origin in any part of that vast prairie country. Some of the more local of these hot, dry winds may originate or acquire their peculiarly high temperature on the mauvaises terres of Wyoming or the table lands of Arizona and Mexico; but the more general simoons most probably have their origin at a far greater distance from us, viz., in the tropics. These simoons in Missouri always blow from the southwest, in Kansas from south, southwest, and in Eastern Colorado south,

or a few points east of south; and their injurious and scorching effects are not unfrequently felt before the frost in Kansas and the country to the west is fairly out of the ground. 2.—It is well known that the buffalo grass ranges over a vast extent of our Western plains, and that it does not furnish a very dense or thorough covering, even when unburned. 3.—My own observations for the past fourteen years in this Western prairie country lead me to the conclusion that fires more often succeed than precede drouth, and that they may more justly be looked upon as a result than as a cause of excessive dry weather; and the prevailing belief that large conflagrations or extensive fires are conducive to rain, bears on this point. 4.—Whenever grass is burned during the growing season, the old and drier blade is soon succeeded by a green and succulent one, which has far greater power to attract and retain moisture; while if burned in Winter time the evaporation from the soil can be thereby but slightly affected, because of the weakened power of the sun, and the snows which usually cover and protect. 5.—Drouths are by no means confined to that portion of the country subject to the locust invasions. 6.—The reason why locusts are more sluggish and less inclined to fly at morn than at noon is not so much a question of the comparative density of the atmosphere as of the difference in temperature. All diurnal insects are sluggish in the cool of the morning, and their activity increases with the rising of the thermometer; and flight, whether of bird or insect, is, I conceive, easier, *cœteris paribus*, in a dense than in an attenuated atmosphere. 7.—The reason why the Rocky Mountain Locust does no damage in the Eastern States, and never reaches beyond a line drawn at a rough estimate along longitude 17° west from Washington, is, I take it, rather because, first, there is a definite limit to its power of migration from its native home in a single season; second, because the new conditions which it meets with in the lower country forming the eastern limit, injuriously affect it and kill it off in the course of one or two years. 8.—The statement about the Kansas City region is simply incorrect, as the locusts were thick around that city the present year. 9.—As the Rocky Mountain Locust multiplies only in the Rocky Mountain region, its descent into the plains to the East where it cannot thrive, cannot well be affected by the burning of the grass on those plains.

Having thus given some facts which militate against the conclusions arrived at in the *Kansas Farmer* article, let us now consider, as a still farther offset against those conclusions, the benefit resulting from the burning of prairies. Fearful as are the ravages of locusts, they are only periodically as general and widespread as they were the present year, and if we consider the annual damage done to the crops of Kansas by any one insect, the Chinch Bug must, I think, be set down as a greater enemy to the Kansas farmer than the Hateful Locust. Even this year, in the eastern portion of that State, the chinch bugs, aided by the excessive dry weather, had so depleted, by their myriad pumping beaks, the later ripening cereals, that these would have made but a very poor return for the labor spent upon them, even had the locusts not made their advent. Now there are no better preventive measures against the injuries of the Chinch Bug than the burning of the grass on our prairies and around our cultivated fields, and the destruction, by the same means, of weeds, leaves, corn-stalks and all other litter and rubbish around such fields, and as far as possible within the woods. For the Chinch Bug hibernates under just such shelter as this litter affords, and the proper season to attack it is in the Winter time, and not at or just before harvest, when it, in great measure, baffles human control.

This statement might be substantiated by a long list of facts in the insect's economy, which it is unnecessary to mention here, and I will simply add in testimony that in Illinois, before the country was as thickly settled as now, and when immense fires annually swept over her prairies, the ravages of the Chinch Bug were scarcely known. It is therefore very patent that the judicious burning of the dead grasses, especially in the vicinity of cultivated fields, will reduce the ravages of this worst of the farmer's pests, and the same will hold true of the False Chich Bug (*Nysius destructor*), which affects our garden vegetables and other tender-leaved plants in the same way as the genuine Chinch Bug affects our cereals. It is also true of many other destructive insects which shelter under dead grass and herbage during the Winter. But, most important of all, it is also true of the young locusts and of locust eggs, immense numbers of which undoubtedly get destroyed by such fires. A strong impression also prevails among farmers, and it is not without foundation, that the burning of our prairies is beneficial in that it returns at once the potash of the plant to the soil, instead of through the slower process of decomposition. From these premises I think we may safely draw the following conclusions:

1.—That the non-burning of the prairies will not prove a cure for all the ills that Kansas is subject to. 2.—That, on the contrary, the judicious burning of such prairies will prove a measurable cure for some of her most serious ills. Indeed, there is only one way in which there can be any real connection between the burning of prairies and the ravages of the Rocky Mountain Locust, and that connection is through the remote past, and altogether beyond our present control. In the report of the Chief Signal

Officer to the War Department for 1872, will be found an interesting account of the great fires of 1871 in the Northwest, by Prof. J. A. Lapham, of Milwaukee, Wis., in which my learned friend maintains that our extensive Western prairies and plains owe their existence and origin to the agency of fire. These fires, encouraged by drouth, and either kindled by accident or intention, have swept over the country for ages, and while they leave the roots of the grass uninjured, they destroy the germs of most other plants, including forest trees; and Mr. Lapham pictures to himself a long-past struggle between forest and prairie, in which the latter, by the assistance of the Fire King, has gained and held the vantage ground.

While I do not agree with Prof. Lapham that the remote cause of our prairies can be attributed to fire, yet no one can doubt its agency at the present time in maintaining these prairies and preventing timber growth in the more humid portions of the great prairie region. But on this hypothesis there would naturally be a connection in the past between fires and locusts; for if without fires this whole prairie region had been timbered, the locusts, which are essentially insects of the plains and prairies, could never have become so prodigiously abundant and injurious. On such a hypothesis alone can I see any possible connection between prairie fires and locust invasions, and, however much truth there may be in the hypothesis, the fact remains that there is no present connection between the two phenomena.

APPENDIX

TO THE

ARTICLE ON THE ROCKY MOUNTAIN LOCUST.

The length which this Report has already attained precludes the publishing of any of the many answers to my circular from the different counties of Missouri. There is so much valuable experience, however, in the following letters, by three valued and intelligent correspondents, from Texas and Kansas, that I feel constrained to publish them entire, as a fitting sequel to what I have said on the Rocky Mountain Locust:

Letter from the late Thos. Affleck, of Brenham, Texas, written in 1868.

About the first week of November, 1867, locusts appeared here, but were announced towards the northwest of us as being on the way some weeks before. They came down from a considerable height in showers about like a fall of snow—their silvery wings contributing to the resemblance. On looking toward the sun, they could be perceived in vast clouds, at a great height, and all steering to the southeast.

They were busily engaged devastating the crops about Union Hill, five miles to the west, for a week before they made their appearance here, and were nearly two weeks longer in reaching Brenham, seven and a half miles to the south-by-east. They were very few in number to the south and east of that town.

Immediately on alighting, they began to devour every green thing, possessing ravenous appetites; and also copulated in great numbers, after which the males gradu-

ally disappeared. As food failed them, they would occasionally take to wing in small bodies and go off; but generally "took it afoot" in search of fresh pastures. Everything green in the gardens, turnip patches, wheat-fields, etc., was devoured; and much of the Winter or Prickly Mesquit Grass (*Stipa setigera*) so as greatly to lessen the weight of pasturage, and stint the stock.

When I reached home, about the first of December, they were busy depositing their eggs, and had been so for some two or more weeks before. The female selected high and dry spots, and especially little ridges of hard ground on paths, roads and beaten yards, formed by the washing of water.

They were preyed upon by birds, animals, and other insects. What few hogs were hereabouts, devoured them greedily, as did poultry; they gradually disappeared without being able to say how.

We had some very bad freezes for this latitude, the ground being frozen to a depth considerably below the nests of eggs; and this more than once freezing and thawing during the Winter. We were in hopes that this would have destroyed them, and in rich, black, prairie soil, many thus perished. But enough were left to produce untold myriads of the pests. They began to hatch early in February; when first seen, they were about the size of a big flea; but a few continued to appear for six weeks or more. I perceive, from my "Jottings on the Farm," in the *Houston Telegraph*, that on the 28th of March they began to move—having hitherto fed about close by where they were hatched—though only about five-eighths of an inch in length, and without wings.

I quote from these jottings: "My garden is located on rich, stiffish valley land, and, by the way, is in a very promising condition. Until yesterday there was not a Locust within the twenty acre lot, of which my garden now forms a small part. But two days ago, the *varmints* began to move, on their 'nor'-west coorse,' and accumulated in fearful numbers along the east and south lines of the fence. Strange enough, however, they did not seem inclined to cross over, which they could easily have done by hopping through between the rails. After a day or two of hesitation, they made a fresh start yesterday morning, and poured in on me in myriads. By night, I should say, at a rough guess, that about one hundred bushels, more or less, if carefully measured up, were within the limits of these twenty acres! They took a line diagonally across, hopping along at a rate that would take them over the ground about a mile per day. They present a very singular appearance indeed; not one diverging from 'the way they should go,' or are impelled by their instinct to go. The advance soon struck the north line of the fence; vast numbers, still behind, made no movement beyond a certain strip of prairie sod, left as an intended carriage drive. But, instead of crossing it, they followed it down; clipping the leaves partially from a nice young hedge of Mariëtta rose, and threatening the potato patch. I could not stand *that*. So, taking a branch in each hand, I hurried them up, at the same time fending them off from the potatoes. They submitted to be driven quite as readily as a flock of sheep, so that I still hope to save my garden."

"April 3. These locusts have taken possession of a young orchard of Peach and Almond, and of a lot of fine dwarfed Pear trees (of many varieties, and about eight feet in height, full of blossom) which were very promising. They *roost* on the trees at night; breakfast on the leaves and young fruit, before lunching and dining on the grass and buds. Yesterday I could not drive them, and to-day the ground is so wet, they won't be driven. And, worst of all, the bulk of them are to the southeast of my vegetable garden."

"April 11. Still keeping up the fight with the locusts. I fought with fire; drove them into the stream of water, and in every way in my power, helped them on their way or destroyed them. A large flock of blackbirds came to my assistance, and did great service. They are now nearly gone, and I hope will soon take flight.

"April 18. I have been consoled to-day with the assurance that there are more locusts in this valley (Glenblythe) than anywhere else in the county.

"April 23. Vast numbers of the locusts have gone off, leaving only those of tender age, but possessing wonderful appetites. Some of them got off by flight, but the bulk kept on, on foot, towards the northwest, followed and preyed upon by hundreds of Black Hawks, or rather Buzzards, I think the *Falco Harlani*.

"April 29. Still a few left, but no more than the poultry and I can manage.

"I saved about two-thirds of my garden; but by constant toil.

"None copulated before leaving, and of course no eggs were left to perpetuate the curse, and it may be many years before they again visit this now sufficiently oppressed country.

Letter from Mr. S. T. Kelsey, Hutchinson, Kans., Forester to the Atchison, Topeka and Santa Fe R. R. Co.; written August 5, 1874.

The migratory grasshoppers (*Caloptenus spretus*) have again appeared in Kansas, and I hereby send you a report of their operations as I had promised. I first saw them at Hutchinson, on the Atchison, Topeka and Santa Fe Railroad, where they appeared on Sunday, July 26, at about 6 o'clock P. M. They were so thick in the air that they appeared like a heavy snow storm; those high in the air forming apparently light fleecy clouds, while those dropping to the earth resembled flakes of falling snow. Next morning, Monday, the 27th, at daylight, the country was literally covered with grasshoppers. Soon after sunrise, they collected on the growing crops, young trees, etc., and commenced eating, and before night had eaten the leaves from almost every green thing. All that I know of their leaving unhurt is sorghum, castor beans and honey locust trees. They did but little harm in most places to the cottonwood, box elder, Osage orange, elm, black walnut and oak, and such prairie weeds and grasses as were a little dried. They have worked some upon every tree that I have, except the honey locust. In some places, they have eaten the leaves, bark, and even the wood of the one and two year growths. On Tuesday morning, the 28th, I went west on the Atchison, Topeka and Santa Fe Railroad, and found that the grasshoppers reached the Arkansas Valley, as far west as Larned, on Sunday evening; on Monday, they appeared as far west as Pierceville; on Tuesday, as far as Aubrey; and on Wednesday, at 2 P. M., they appeared in force at Granada, Col., the terminus of the Atchison, Topeka and Santa Fe Railroad. I am told by persons who have come down the Kansas Pacific Railway that they extend on that line from Junction City, Kans., to Denver, Col.—a distance in direct line of about 450 miles. I have not been able to learn whether they extend west of Denver. They seem to be moving a little west of south—the first of the column occupying, as near as I can learn, nearly a straight line, at about right angles with the direction they are moving. The wind appears to change their course a little, but, I think, not very much.

They strip the country as they go, except the old, tough grasses and some things I noticed before, and then rise and fly—probably to the front of the column. I am not able yet to ascertain certainly how wide the column is, but it must be 200 to 300 miles in width. They are doubtless the same that have been destroying the crops of Western Iowa and Minnesota, and from the notes that I get from the north, I expect they have, in their course, destroyed all the growing crops of Central and Western Nebraska, as well as Kansas. They have not commenced to copulate yet, and will likely pass down into Texas or New Mexico to deposit their eggs.

I was told yesterday, by parties just from the north, that another column was moving down farther east, and taking a more easterly course, and would, if they kept on, strike through Eastern Kansas; however, I do not believe the story. Will post you if they do come. I learn from reports, and from parties who have traveled in British America, that they breed far up into that country, and as far south as Mexico. Thus it appears that nearly one-half of all the territory of the United States, excepting Alaska, is subject at intervals to the devastation of this migratory grasshopper, and it

seems of great importance to the people of the West and the whole country that we should get all possible information respecting them, and the best means for destroying them or preventing their ravages. I am looking the matter up, and any further information that you may desire will be cheerfully given, so far as possible.

I am told that some fields of corn have been saved by building fires so that the smoke would pass over the field, and the grasshoppers would get up and leave on short notice.

Letter from Mr. E. Snyder, Nurseryman of large Experience at Highland, Kansas, written January 11, 1875.

The first appearance of the Rocky Mountain Locust, more commonly known here as Red-legged or Army Grasshopper, in this section of country, was about the 10th of September, 1866.

People who have lived here forty years, say this was the first time these grasshoppers made their appearance to their knowledge.

At our place they commenced coming down about 1 o'clock in the afternoon, at first only one at a time, here and there, looking a little like flakes of snow, but acting more like the advance skirmishers of an advancing army; soon they commenced coming thicker and faster, and they again were followed by vast columns, or bodies looking almost like clouds in the atmosphere. They came rattling and pattering on the houses, and against the windows, falling in the fields, on the prairies and in the waters—everywhere and on everything.

By about 4 o'clock in the afternoon, every tree and bush, buildings, fences, fields, roads, and everything, except animated beings, was completely covered with grasshoppers. When they first alighted, they seemed exhausted, but it did not require much time for them to recover and become familiar with their new surroundings; they almost immediately commenced devouring and destroying plants with a voraciousness and rapidity truly astonishing to one not acquainted with them.

After about 4 o'clock few could be seen flying, except when disturbed, or making short trips probably in quest of food. They seemed to be inclined towards dry, warm places for the night, and all such places were packed and crowded by the time the sun went down.

They commenced depositing eggs almost as soon as they arrived, and the earth in many places presented the appearance of honey-comb, being caused by the boring or perforating process of these insects, preparatory to the depositing of the eggs. In this they showed a decided preference for hard, warm, dry places, such as roads, new breaking of prairie sod, etc., often selecting places so hard that it was difficult to penetrate the ground with a spade or sharp pointed stick; shady, moist places were partially avoided, although almost every spot of ground secured some.

The grasshoppers remained, and continued depositing eggs until after hard frosts, but became less abundant, and of less vitality, as cool weather and frosty nights approached. There was considerable rain during the Fall, and the hopes and predictions were that the wet weather would destroy the vitality of the eggs, and many thought their coming a mere accident, the first time they were ever here, and they would not trouble us any more

As cold weather came on, they collected more toward warm spots; wagon roads and railroad tracks, being warmed up during the day by the heat of the sun, were completely covered, and as they seldom move at night, the morning after found them stiff and numb, especially on the iron rails, from which they could not move until the sun warmed them up again, and railroad trains often had difficulty in getting up the grades on account of the wheels and track getting slippery, which gave rise to the story that "grasshoppers were so thick they stopped the cars."

Whatever our calculations may be, nature works according to laws we cannot

change, and accordingly the following Spring we had a practical demonstration whether the eggs deposited the previous Fall would hatch or not. Although the Fall had been quite wet, with considerable rain in the Spring, and freezing and thawing in the interval, the eggs seemed to be proof against any kind of weather, and myriads of young grasshoppers hatched out as soon as the weather was warm enough. About the latter part of April and first of May appeared to bring forth the great bulk of them. They were apparently harmless little mites at first, but as they grew older and larger their voraciousness increased, and when nearly grown their destructiveness was alarming, and could only be understood by those beholding it. The young grasshoppers could not fly; but during the month of June, commencing about the first, they divested themselves completely of an outside skin, even unto the legs and feet, and came out a winged insect, and soon thereafter took their flight and left us.

In the month of September following (1867) they came down again, but not so many as the previous year. They again deposited eggs, but not in such vast quantities as before. A large proportion of the grasshoppers had attached to their wings or other portions small red insects, and also contained inside of them small white worms or maggots.

The Spring following (1868), the eggs again hatched out, but they were more under control of their various enemies, and the damage inflicted was not so much nor so general as the previous season, and they became infested with mites and worms before they flew away in June.

The next appearance of these pests was in August, 1874, and this invasion is still fresh in the memory of nearly every one familiar with the name of Kansas or Nebraska.

They have their preference for certain kinds of food, but in the absence of what they like best will eat almost anything. I have known them to eat the outside off of fence posts and boards, and other weather-beaten timber, until it looked as if the outside had been hacked or chipped off. I have had all the foliage and bark, and the ends of twigs, eaten off of young trees by them. Soon after coming down, they commence moving around, something like the foragers of an army, and soon gather and collect on such things as they like best in great numbers. Almost all the ordinary crops of the farm and garden seem to be desirable forage for them; but among the things that are most eagerly devoured are cabbage, onions, radishes, etc. I have frequently seen onion and radish beds with nothing left but the holes in the ground where they grew, having been eaten clean out. I have succeeded in raising tomato plants, but the ripe tomatoes are generally eaten. Apple and pear trees are stripped of foliage, and sometimes part of the bark; but the fruit is not often eaten, but left hanging on the trees. The foliage of peach, cherry and plum trees generally escapes, but the fruit, especially peaches, is generally destroyed, leaving the pits hanging on the trees. Willows and poplars soon become stripped of foliage—the tall Lombardy poplar sometimes looking like an immense swarm of bees, being almost covered with grasshoppers from the top to the ground.

While few vegetate things of value as food for people escaped without damage, there was a very noticeable difference in the amount of injury the same varieties of trees or plants sustained under different circumstances. For example: One tree or plant out of a number of others of the same kind might be entirely destroyed or devoured, while all the rest would be but slightly injured, or part of the same lot would be badly injured, and part but slightly. Upon examination it was always found that when this difference occurred, it was due to a decline in the vitality of such trees or plants as were mostly injured. It was quite noticeable that newly transplanted things were more subject to being fed upon than well established ones; that any tree in an orchard of the same variety that was injured by borers, excessive bearing, or from other causes, would be entirely stripped of foliage, while the others would not. And

even in corn-fields, where plowing was done so as to injure the roots and cause the corn to wilt, they left the more vigorous growth and attacked the injured. I have observed a number of them get around the base of a growing corn-stalk an inch in diameter, and gnaw it off close to the ground, like a lot of beavers gnawing off a tree; and as soon as the corn fell to the ground, there was a rush for it by others that seemed to be in waiting, and the fallen stalk would disappear at an astonishing rate.

Of course they do not confine themselves to this kind of diet, and yet they seem to prefer it, as is shown in the eagerness by which they feed upon any vegetable growth that is wilted or on the decline. They show this disposition towards their own family, for whenever any of them get killed or disabled, others go to work and eat them up, the one being devoured by the others will kick and struggle as long as life remains, (and they have a wonderful tenacious life,) but it is all of no use, the length of life only depends on how long it will take the others to eat it up. Young plants just coming from the seeds, being weak and easily destroyed, are also particular objects of the tastes and appetites of these insects.

Having learned that their favorite places, or their resorts of choice, are hard, dry, warm places, and their preference in food such as is not strongest in vitality, the remedies most successfully employed against them here are early planting, good and thorough cultivation, and the production of thrifty and vigorous growth in crops.

In wet or cool weather they are comparatively harmless, being scarcely able to fly or eat; in clear weather the air is filled with them, (after they commence flying); in cloudy weather few can be seen flying, and on wet or rainy days they do not fly at all.

Their habits seem to be restless and migratory; they show this disposition as soon as they hatch out in the Spring, first collecting on patches of May-weed and smart-weed, and other things suited to their tastes and natures. They will move in bodies from one point to another in search of food to suit them. While young, and before they have wings to fly, they move in a peculiar manner, by walking a short distance and then jumping. In their travels they prefer hard ground, as it is somewhat difficult for them to travel (walk and jump) on loose ground. Thus it is that corn-fields of considerable size, when well cultivated, generally escape destruction, especially if the corn gets a good early start in growth. And I think there is no doubt but that a continuous and thorough working of ground by horse power, is a good safeguard against these insects from the time they hatch out until they fly. It may not be practical to save small tracts or lots of ground in this way, because they may encircle from all sides and overrun it.

I am one of those who believe there is a final remedy for every evil, and to know how to overcome them is simply a matter of time and study, and we may as well get right to work and prepare ourselves to meet and overcome, as well as we can, every calamity and misfortune that is likely to come in our way.

That the insect in question is one of the greatest scourges this splendid country is subject to, too many have the misfortune to know, and the past gives but little reason to hope we will not be troubled with them in the future, unless some organized practical method be adopted to destroy their power for harm.

INDEX.

ERRATA.

Page 5, line 16, for "State" read "state."
Page 7, line 7, for "calubrine" read "colubrine."
Page 17, last line, note, for "Dep. de l'Hèrault" read "Dép. de l'Hérault."
Page 21, line 14 from bottom, for "Lencopterus" read "Leucopterus."
Page 39, under Fig. 6, for "TTIM" read "TRIM."
Page 80, under the heading, add "(Ord., LEPIDOPTERA; Fam., PHALÆNIDÆ.)"
Page 90, under the heading, add "(Sub-ord., HOMOPTERA; Fam., APHIDÆ.)"
Page 94, in the sub-head, for "gall-inhabiting" read "root-inhabiting."
Page 124, line 10 from bottom, for "*Coloptenus*" read "*Caloptenus*."

EIGHTH ANNUAL REPORT

ON THE

NOXIOUS, BENEFICIAL,

AND OTHER

INSECTS

OF THE

STATE OF MISSOURI,

MADE TO THE STATE BOARD OF AGRICULTURE, PURSUANT TO AN APPROPRIATION FOR THIS PURPOSE FROM THE LEGISLATURE OF THE STATE.

BY CHARLES V. RILEY,
State Entomologist.

JEFFERSON CITY:
REGAN & CARTER, PRINTERS AND BINDERS.
1876.

PREFACE.

To the President and Members of the State Board of Agriculture:

GENTLEMEN: The following pages constitute my Eighth Annual Report on the Noxious, Beneficial and other Insects of the State of Missouri.

The year 1875 was notable in the annals of our State by the ravages of two insects more particularly, viz.: the Army Worm and the Rocky Mountain Locust, and the present Report is, consequently, largely devoted to them. Of the former species I have been fortunate enough to ascertain, by direct observation, the mode, place and time of oviposition, which have hitherto remained unknown, notwithstanding the insect is at times so very abundant and destructive, and notwithstanding that on our knowledge of when and where the eggs are laid, depends our most successful and simple means of preventing its injuries. I have deemed the matter of sufficient importance to delay the closing of the Report in order to add some supplementary notes, giving an account of the eggs and of the early stages of the worm.

On the Rocky Mountain Locust I have dwelt at length, embodying the dear-bought experience of the year. The fearful ravages of this pest and the destitution and suffering which it caused in our western counties, in the Spring of 1875, are too fresh in the minds of our people to need further notice. They warrant the large amount of space devoted to the subject in the following pages; and I trust that in the event of a repetition of such visitations as those of 1874 and 1875, the record of experience, the suggestions and recommendations in this and the preceding Report, by being placed before our farmers in available form for reference, will enable them to successfully cope with the enemy and avoid the loss and suffering experienced the past year. I would especially call the attention of the members of our next Legislature to what I have said on pp. 32-40, where I hope that the necessity for some action on their part is demonstrated.

It is gratifying to know that my conclusions and predictions published last Spring were justified by subsequent events, and, so far as we can judge from the indications, it is shown in the following pages that our farmers are not likely to seriously suffer during the year 1876 from any of their three worst insect enemies—the Army Worm, the Chinch Bug and the Rocky Mountain Locust—and I hope that the apprehensions that exist, regarding this last more particularly, will be allayed by what I have recorded.

Once more I must refer to the inconvenience of having these Entomological Reports bound in the same volume with that of your Secretary. Instead of being distributed in April, when it was out, and when the information contained in it was most being sought for, my last, as I am informed by the Secretary of State, was not

sent out till into the Fall. From a small, separate-bound edition, which I always have published and sent out at my own expense, it was noticed, and extracts were made from it, both at home and abroad soon after its completion; but the fact nevertheless remains that it was not distributed among our farmers till long after many of them had applied for it; and the only way to avoid such difficulties in the future is to have the two reports separately bound.

As it is frequently advisable to give to the public facts to be embodied in these Reports when they are yet fresh and most useful, I have chosen as media for so doing the New York Weekly *Tribune* and *Colman's Rural World* more particularly, so that some of the matter in the present Report has already appeared, generally over my own name or initials, in the columns of those journals.

In this, as in the previous volumes, when the insects treated of are new, or the existing descriptions of them are imperfect, or in a foreign language, or in works out of print or difficult of access, I have added a full description, which is, however, always printed in smaller type, so that it can be skipped by the non-interested reader. I have endeavored to give a popular name to each insect of economic importance, and this is invariably accompanied, wherever accuracy demands it, by the scientific name, and the latter is generally printed in *italics* and mostly in parenthesis, so that it may be skipped by the practical man without interfering with the text. The Order and Family to which each insect belongs, are also given under each heading. The dimensions are expressed in inches and the fractional parts of an inch. Where so small, however, as to render such measurement inaccurate, I have adopted the milimeter—one milimeter (1 mm.) not quite equaling twenty-five hundreths of an inch (0.25 inch.) The sign ♂ wherever used, is an abbreviation for the word "male," the sign ♀ for "female," and the sign ☿ for neuter.

Some of the figures are enlarged, but the natural size of each of such is also given or indicated by a hair-line, except in the representation of enlarged stuctural details, where they are connected with the life-sized insect to which they belong.

The name of the author of the species, and not of the genus, is given as authority; and in order to indicate whether or not the insect was originally described under the generic name which it bears, I have adopted the following plan: When the specific name is coupled with the generic name under which it was first published, the describer's name is attached without a comma—thus indicating the authorship of the dual name: e. g. *Phycita nebulo* Walsh. But when a different generic name is employed than that under which the insect was first described, the authorship is enclosed in parenthesis thus—*Acrobasis nebulo* (Walsh;) except where the whole name is already in parenthesis, when a comma will be used for the same purpose: e. g. (*Acrobasis nebulo*, Walsh.)

All the illustrations, unless otherwise stated, are drawn by myself from nature.

My office is still at Room 42, St. Louis Insurance Building, N. W. Corner of Sixth and Locust Sts., where all communications should be sent. I tender my cordial thanks to the officers of the Iron Mountain, K. C. & Northern, and Mo. Pacific Railroads, for courtesies extended, in the way of passes, over their respective lines.

Respectfully submitted,

CHARLES V. RILEY,

State Entomologist.

ST. LOUIS, MO, May 15, 1876.

TABLE OF CONTENTS.

INNOXIOUS INSECTS.

NOXIOUS INSECTS—*Continued.*

NOXIOUS INSECTS.

THE COLORADO POTATO BEETLE—*Doryphora* 10-*lineata* Say

(Ord. COLEOPTERA; Fam. CHRYSOMELIDÆ.)

In accordance with previous custom, I herewith record such notes on this insect as are suggested by the past year's experience with it and as are deemed of sufficient interest.

DAMAGE DURING THE YEAR.

The summer in Missouri was so excessively wet that although the beetle was abundant enough in the spring it subsequently became comparatively scarce and harmless, and did not again become multiplied till after the rains had ceased and the third brood had developed; by which time the crop was sufficiently matured to be out of danger. Very much the same conditions occurred all over the upper Mississippi Valley country, and as there was an increased acreage planted, the crop throughout this whole section was larger and prices lower than they have been for many years. Indeed in some parts of Michigan, Ohio and Indiana, it has been difficult to dispose of potatoes at even 25c. per bushel.

IN THE ATLANTIC STATES

the insect attracted much more attention. From almost all parts of New York, New Jersey, Pennsylvania and Virginia, accounts came of the excessive numbers in which the pest made its appearance in the months of May and June. Local papers throughout the States mentioned, published records of the insect's injury and laid the experience that had been gained in the States to the West before their readers; while even large city dailies, like the *World* and *Herald* of New York, devoted column after column to Doryphora's consideration.

Judging from the mass of accounts, the first brood was very generally neglected by those who had not before had experience with the insect, and not till the more numerous second brood appeared did the farmers awake to the importance of action, and, as far as possible, concerted action. Much injury was consequently done.

Later in the season the beetle at times swarmed in and about the large cities, and was commonly seen flying in the streets of Philadelphia and New York, as in past years it had been seen in those of St. Louis. Mr. J. J. Dean of New York, after referring to its frequency in the streets of Brooklyn, gives me the following interesting account of its occurrence on Coney Island.

> On the 14th of September I picked up the enclosed specimen at Coney Island. The beach for miles was covered with them—the hummocks and sand-hills which comprise the greater part of the island were literally alive with them. In the towns of Flatbush and Gravesend, both situated in King's Co. — the latter town including Coney Island within its boundaries—the ravages of this insect have been very serious. The Egg-plant seems to have afforded him his favorite article of diet. I am however puzzled by the fact that so many millions of them desert the fertile fields of Flatbush and Gravesend and steer for the barren acres of Coney Island, on which the principal vegetation is a coarse sea grass which they do not seem to touch. They appear to have an irresistible tendency to travel East and are only stopped by the waves of the Atlantic Ocean.

In the Fall the insect reached up into Vermont and extended to within a few miles of Boston,* but has not yet occurred in Maine.

ITS SCIENTIFIC NAME.

In further support of the views expressed last year on this subject, I will add that an examination which I was permitted to make last summer of the admirable and extensive collection of Chrysomelidæ belonging to H. W. Bates, of London, shows that the tibial groove on which Stal founds his new genus *Leptinotarsa*, to which our potato beetle is referred and under which it is published in Gemminger and Harold's Catalogue, is really of no generic value. Several genuine Doryphoræ with the sternal spine fully developed have it in varying degree, and in *concatenata*, Fabr. it is even more conspicuous than in 10-*lineata*. I fully agree with Dr. LeConte, that if any character has value in separating 10-*lineata*, it is the form of the palpi which ally it more to *Doryphora* than to *Chrysomela*, and make of it, with a few others, a natural group in that genus, distinguished by peculiar coloration and want of development of the sternal spine.

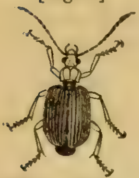
---

* Mr. Geo. H. Perkins, Prof. of Geology and Zoology in the University of Vermont writes: "It may interest you to know that the Doryphora 10-lineata, the genuine animal, was found in the western part of this State last August. I think it did not appear much before, as I was on the look out for it." Dr. Packard (*Scientific Farmer*, Feb. 1876) records its appearance at several places in Massachusetts.

NATURAL ENEMIES.

The different natural enemies that have been enumerated in these reports were often found efficiently working to aid man in destroying the pests, and two additional ones have been reported. Mr. P. R. Uhler found the Black-bellied Lebia (*Lebia atriventris* Say, a species of the same color and general appearance, but only half as large as *L. grandis*, Fig. 1) destroying it around Baltimore; while the editor of the *American Agriculturist* in the January (1876) number of that excellent journal, gives good evidence (p. 18) that the common crow devours the beetles, and even digs up the ground to get at them after they have entered it to hibernate.

[Fig. 1.]



LEBIA GRANDIS.

REMEDIES.

The prevailing remedy has been the Paris Green mixture recommended in the Fifth Report. Mr. Trask Lee, Trumble Co., Ky. (*Country Gentleman*, April 29, 1875) shows that with flour that cost him $6.50 per barrel (the poorer and cheaper quality answering as well) he protected 8½ acres at a cost of $17.42, including labor. He prefers flour and Paris Green to everything else; and so does Mr. Elias Mott (*ibid.* April 8, 1875) and many others for the reasons which I have already given. "T. of Iowa," in which signature I recognize an old friend and intelligent observer, gives the following experience in the *Prairie Farmer* for July 3, 1875:

> I have had quite as good success in using the ingredients from which the green is made, as from the finished article, bought in paint and drug shops at 50 cents a pound, especially when the local demand is so great that it cannot be bought at all. The following directions for making it are taken from Brande's Chemistry: Dissolve two pounds of sulphate of copper, blue vitriol, (costing 20 cents per lb., or 40 cents) in a gallon of hot water, keeping it in a stone jar. Dissolve in another large jar, one pound of white arsenic, (costing 10 cents), and two pounds of saleratus or pearl ash (cost 20 cents) in forty-four pounds of hot water, stirring well, till thoroughly dissolved. These articles, costing 75 cents, will make about five pounds of Paris green, costing $2.50. I usually keep them in solution and mix in the proper proportions, one part of the first to five of the latter, as they are needed. The green immediately begins to precipitate in a fine powder, and is much more convenient for use, in solution, than the dry article sold in the shops.

Among the novel methods that have been employed in defence against Doryphora, two are more particularly worthy of mention as being reasonable and preventive, and as having been employed with success. The first is to slice potatoes, dust the pieces with Paris Green and drop them about a field early in the season when the beetles come from their winter quarters. They feed upon the slices and of course die. The method can only be safely practiced where no domestic animals can get at the baits. The second is that first employed by Mr. James Rivers of Cass County, Mich., viz., a mixture of chicken manure

and ashes, applied to each hill of potatoes just as the plants are coming through the ground—the object being to check the cracking and raising of the soil, and thus prevent the beetles from hiding around the young plants at night or during cold weather. The application appears in addition to keep the beetles off, at the same time that it invigorates the plant.

Col. Fred. Hecker, of Summerfield, Ills., writes me that he had the past summer a patch of potatoes covered with straw, which had entire immunity from the insects' attacks; but it is doubtful whether under the same treatment such immunity could always be relied upon.

Of machines not previously referred to, Mr. S. S. Rathvon of Lancaster, Pa., speaks very favorably, from experience, of one patented by Mr. Anthony Iske of that town. It is a machine simple in construction, but is quite effective in sweeping the bugs from potato and tobacco plants into receptacles provided for that purpose. It is composed of two pieces of tin gutter pipe, about two feet long, which hang near the ground, one on each side of the row of plants, while above them is suspended a broom. The revolution of the wheels on which the machine is propelled causes the broom to vibrate from side to side, knocking the bugs off the plants against wooden shields, which are placed behind the gutters into which the insects fall. The gutters are said to be adjustable and to accommodate themselves to the

[Fig. 2.]

Peck's Spray Machine.

shape of the ground and the size of the plants. From plans and descriptions which have been submitted to me I am not very favorably impressed with the invention. The machine looks cumbersome; and the work it proposes to do can, I think, be done in a more simple way.

An excellent spray machine carried on the back after the style of the Gray Sprinkler described in my last report, has been invented by Mr. W. P. Peck, of West Grove, Pa., who kindly sent me one of the machines for trial with the following explanatory remarks: "Like many an other inventor I have found something to do since I thought my invention complete. To apply a liquid to trees there must be force to raise it above the tank. My plan for doing this is to connect the blower with the tank by means of a rubber pipe passing over the left shoulder which creates a pressure of air in the tank. By this means liquid can be raised two or three feet above the head and by the aid of a step-ladder six or eight feet in height we are able to make application to trees 14 or 15 feet from the ground. I have been trying and hoping to discover some plan that would enable me to do without the step-ladder and have delayed sending out any Atomizers until I could do so, but have given it up for the present, and the company have begun to fill orders."

This atomizer, can of course be used to distribute other liquids than Paris Green water, and to protect other plants than potatoes; but for use in the potato field it answers an admirable purpose. The tank holds three gallons and there is a simple device at the bottom which by the motion of walking keeps the liquid in agitation and prevents the mineral from settling. The liquid issues in so fine a spray that it is scarcely perceptible.

FURTHER EXPERIENCE WITH PARIS GREEN.

Last year I discussed the value of this mineral as an insecticide, especially in reference to the insect under consideration. So far as past experience, and the facts at that time known, permitted, its influence on the plant, on the soil, and on man either indirectly through the soil or through the plant, was considered; the conclusion arrived at being that, used with ordinary caution and judgment, it was a valuable and safe remedy. This had long been the conclusion of practical men in the Mississippi Valley who had used it extensively; but the question was opened again by a paper read by Dr. J. L. LeConte of Philadelphia, before the National Academy of Science, which paper, from the theoretical side, strongly condemned the use of the poison for the purposes mentioned, and which naturally attracted considerable attention and was harped upon by the manufacturers of "potato

bug machines," or their glib agents. The National Academy, after the reading of Dr. LeConte's paper, appointed a committee to "investigate and report upon the subject of the use of poisons applied to vegetables or otherwise for the destruction of deleterious insects and other animals," etc.; but that committee has, I believe, made no report yet. Prof. R. C. Kedzie, of the Michigan Agricultural College did, however, carry on a series of interesting experiments last summer, and while visiting the college in August I had the pleasure of witnessing and making notes of the Professor's operations. As he has since given these results to the American Public Health Association, and published an abstract of them in the *Detroit Free Press*, I take the liberty of giving them wider circulation.

First, as to the use of the mineral for the Doryphora. Does Paris Green poison the tuber? Tubers taken from vines that had been repeatedly dosed with the ordinary mixture—as much Paris Green, in fact, as they would bear—gave no trace of arsenic. Regarding the idea, which has been suggested, that the use of the poison rendered the tubers watery and waxy, the conclusion is that such condition is brought about by the stunted growth and destruction of the vines caused by the insect, which thereby prevents maturity of the tuber. Does Paris Green poison the land? This is meant, of course, in the sense of rendering the land unfit for the growth of crops; and Prof. Kedzie justly considers not only its immediate, but its remote effect. Theoretically, one would naturally infer that Paris Green is converted into an insoluble precipitate or salt with the hydrated oxide of iron which exists in most soils; but not resting the matter on theoretical or abstract reasoning, Prof. Kedzie made careful tests and experiments. He passed a solution of arsenious trioxide through common garden soil, and filtered Paris Green in a solution of hydrochloric acid through dry earth. In neither case could any poison be detected in the filtrate by the severest tests. Soil taken from a field of wheat that had been sown with Paris Green at the rate of five pounds to the acre showed no trace of the poison when submitted to any or all of the tests which the soil would get by natural solvents in the field, but distinctly showed the arsenic when treated with dilute sulphuric acid. The Paris Green was sown on the ground early in Spring, and was thick enough to give a very distinct green tint to the surface. The grain and the straw were submitted to careful chemical examination, as were also cabbages grown in soil that had the year before been in potatoes and received a heavy sprinkling of Green. No trace of the poison was found in either, and it was observed that the chipmunks ate large quantities of the grain without injury. The more practical conclusions from Prof. Kedzie's experiments may be thus summed up:

1. Paris Green that has been four months in the soil no longer remains as such, but has passed into some less soluble state, and is unaffected by the ordinary solvents of the soil. 2. When applied in small quantities, such as alone are necessary in destroying injurious insects, it does not affect the health of the plant. 3. The power of the soil to hold arsenious acids and arsenites in insoluble form will prevent water from becoming poisoned, unless the Green is used in excess of any requirement as an insecticide.

These experiments of Prof. Kedzie's accord, so far as they refer to the influence of Paris Green on man through the plants, with others by Prof. McMurtrie of the Department of Agriculture, which showed that even where the Green was applied to the soil in such quantities as to cause the wilting or death of the plants, the most rigorous chemical analysis could detect no trace of arsenic in the composition of the plants themselves. They also fully bear out the opinions which I have always held, and justify the advice which I have given.

Before leaving this subject of remedies for the Colorado potato-beetle, it may be well to say a few words about two other compounds that have been strongly recommended and advertised as such. The most notable of these is that advertised as "Potato Pest Poison," by the Lodi Chemical Works of Lodi, N. J. It is put up in pound packages, which are sold at $1 each, with directions to dissolve four ounces in two quarts of hot water, then pour into a barrel containing thirty gallons of cold water, and use on the vines in as fine a spray as possible. Analysis shows it to be composed of one part pure salt and one part of arsenic (arsenate of copper), and it has the general color and appearance of common salt. Early in September, during quite hot and dry weather, I had this poison tested in a field of late potatoes belonging to Mr. W. Hinterthur of Laclede, Mo., the field having been badly infested during the Summer, but about half the vines having been saved by pretty constant hand-picking. These were at the time fairly covered with the insect in the egg, larva, and beetle states. Five rows were treated with the poison, both according to directions and by finely sprinkling the dry powder over the vines. As soon as the powder touched the larvæ, they writhed and became restless, as with pain, the powder dissolved and formed a translucent coating upon them, and in about three hours they began to die. The beetles were not so easily affected, though they too were in time killed by it. Used as directed, it destroys, but hardly as efficiently as the ordinary Paris Green mixture. A pound of Paris Green, costing much less than a pound of the Lodi poison, will go nearly as far in protecting a field of potatoes, and I cannot see any advantage to the farmer from the em-

ployment of a patent poisonous compound of the nature of which he is ignorant, when a cheaper one is at hand. The color of the Lodi poison is also very objectionable, as there is much more danger in the use of poisons when their color renders them undistiguishable from ordinary salt. The other powder is one prepared by a gentleman in Philadelphia, and strongly recommended as a "potato-bug remedy." It was given to me by Dr. J. L. LeConte for trial. It is a dull, yellowish powder, which when analyzed proves to be crude "flowers of sulphur," containing 95 per cent. of sulphur and 5 per cent. of impurity and coloring matter, such as yellow ocher, sand, etc. A thorough trial on the potato patch above mentioned showed it to be entirely worthless. In conclusion, the fact that Paris Green cautiously handled and judiciously used, is an excellent and cheap antidote to the ravages of the Colorado potato-beetle, cannot be too strongly urged. That it is useful against some other insect pests is also true; but it is sometimes recommended for suctorial insects, which it will not affect as it does those which masticate, and its too general use should be opposed. In an emergency it may be used against the Canker Worm. Yet I cannot recommend it in such a case where other available preventive means are at hand—means which are as simple as they are dangerless.

A method of using it during the year in suspension that gave satisfaction was by pouring a gallon of molasses and a pound of Green into a barrel of water, the molasses having the tendency to make the Green stick better to the foliage.

THE INSECT'S NATIVE HOME.

As in the case of all insects that spread or are introduced from one section of country to another, it is interesting to know the original home or range of the Colorado Potato-beetle, so far as such can be learned, though the question has no especial practical bearing. Following Walsh, I have always believed that this species, which has gradually spread to the Atlantic, originally came from the mountain regions of Colorado, and the reasons given are sufficiently convincing to have been very generally accepted as valid. Nevertheless Prof. Cyrus Thomas questions the soundness of the theory in the following language, which I quote because Mr. Thomas's views are entitled to careful consideration:

The first we hear of its attacking the potato, so far as I can ascertain, is in 1859, at which time it was in Nebraska, about 100 miles west of Omaha; the next we hear of it is in Iowa, in 1861, from which point its progress has been carefully noted. Now, it is not contended by any one that it travels except from potato patch to potato patch. That it manages in some way to get over intervening spaces of a few miles, is admitted, but never over spaces which require the production of intervening broods. Previous to

1859, as is well known, there was an intervening space between the border settlements of Nebraska and the eastern base of the mountains of two or three hundred miles in which there were no potato patches. How are we to account for its bridging this space; what induced it to take up its line of march across this barren region in which there were no settlements? Is it not much more reasonable to suppose the plains themselves formed its native habitat, and that as soon as the pioneer settlements reached this region and the potato was introduced, it commenced its attack upon it, and then began its march eastward along the cultivated area?—*Western Rural, Dec. 4, 1875.*

The weak points in the above reasoning are that it implies, first, that the insect travels only from potato patch to potato patch, and that there must have been potatoes at every few miles between the point west of Nebraska where the beetle was first noticed on cultivated plants and the mountains; second, that no cultivated potatoes were grown on said plains. In truth, however, potatoes were undoubtedly grown around Fort Keaney and other forts and settlements prior to that time, and the beetle may travel by the spreading of other wild species of *Solanum*, and by being carried along water courses or on vehicles. One point that may be urged in favor of the supposition that the insect was indigenous to the plains that reach far eastward into Kansas and Nebraska, is that it was unobserved in potato fields by certain parties in parts of Colorado after it had reached as far as Iowa. The point is, however, weakened by the fact that it was found in great abundance in Colorado by Drs. Velie and Parry in 1864. Another point that may be made is that it is difficult to imagine that an insect with such a natural predilection for *Solanum tuberosum* could have passed from settlement to settlement across the plains without its depredations being noticed and recorded. But this last point may also be turned against Prof. Thomas's supposition, since it is also just as difficult to imagine that the potato patches that have been grown in restricted localities on the plains should have remained untouched, if the insect had always existed on those plains. Moreover since potatoes were cultivated on the eastern borders of the plains in Nebraska and Kansas long prior to 1859, there can be no good explanation why the insect did not sooner commence its eastward march, except on the theory of a natural barrier in the shape of the more barren plains, which had up to that time prevented its advance from more western confines.

Mr. Thomas, in support of his views, supposes that the sand bur (*Solanum rostratum*) originally occurred over the plains in question, citing as proof Gray's "Wild on the Plains West of the Mississippi," and the localities given by Porter and Coulter in their "Flora of Colorado." Dr. Gray's language is altogether too general to help much in the argument, and refers to the range of the plant ten years after the beetle had appeared in Nebraska. Porter and Coulter's localities are all in Colorado, and their "Plains of the Platte" doubtless refers to

the south fork of that river. At all events, nothing is more certain then that the original home of the plant was the more fertile portions of the mountain region, and that, like the beetle which it nourished, it has been for many years extending its range eastward through man's agency in one way and another, and is now rapidly extending across Missouri, where but a few years back it was entirely unknown. Mr. Carruth, of Topeka, says that prior to 1864, it was unknown in Kansas, and Mr. C. W. Johnson, of Atchison, writes me that the coming of Doryphora and of the weed in question were cotemporaneous in that section; that the northern dispersion of the plant from the South-west, through the Texas cattle traffic, afforded the means by which the beetle passed the great stretches of prairie lying east of its native haunts.

Bearing in mind that as early as 1824 Say reported the beetle sufficiently common on the upper Missouri, and that it flourishes most in the more northern of the States, I think we may justly conclude that the native home of the species is the more fertile country east of the mountains, extending from the Black Hills to Mexico, where it becomes scarce, and is represented by *Doryphora undecemlineata* and *D. melanothorax.** Putting all the facts together, we may also conclude that it crossed the great plains through man's agency. That it first reached the more fertile cultivated region to the east, in Nebraska, finds explanation, perhaps, in the fact that travel was greatest along that parallel, and that the insect's natural range extended further eastward in those more northern parts, just as the mountain region does in Wyoming and Dakota.

On the whole, Walsh's theory is doubtless at fault, and needs modification in so far as it implies that the insect necessarily came from Colorado, but I can but think that Doryphora came from the Rocky Mountain region, and that civilization, in the way of traffic, travel, and settlement on the plains, was the means of bringing it, and that if we put not a too strict construction on his language, Walsh's views are in the main correct.

THE POISONOUS QUALITIES OF THE INSECT.

Some interesting experiments, to test the poisonous qualities of these insects, were made during the year by Messrs. A. R. Grote and

* Mr. W. S. M. d'Urban mentions in the February (1876) number of the *Entomologist's Monthly Magazine* (London) finding a specimen of the beetle in a case of Coleoptera sent from New Grenada as long ago as 1845. I do not believe 10-*lineata* occurs there, and am strongly of the opinion that some one of the similarly marked and closely allied species has been mistaken for it by Mr. d'Urban. The 11-*lineata*, for instance, which Stal reports from Mexico, Costa Rica, Bagota, and Bolivia might easily be so mistaken, and was for some time actually so mistaken by the members of the Belgian Entomological Society in the discussions had in that body about a year ago as to the possibility of the importation of our Colorado Potato-beetle.

Adolph Kayser, and reported in a paper entitled "Are Potato Bugs poisonous?" read before the American Association for the Advancement of Science at its meeting in Detroit. The following extracts give the substance of the paper:

> To investigate the matter, a quantity of the bugs collected from fields near Buffalo, where no arsenic had been used, was submitted to distillation with salt water, so as to allow of an increased temperature. Under this process, about four ounces of liquid were procured from one quart measure of the insects. This liquid was perfectly clear, and emitted a highly offensive smell; it proved of alkaline reaction on account of the presence of a certain quantity of free ammonia and carbonate of ammonia.
>
> Again, an equal quantity of the bugs was used to prepare a tincture made as follows:—Absolute and chemically pure alcohol was condensed upon the live bugs; after a digestion of twenty-four hours the alcohol was evaporated at a gentle heat. The tincture so obtained had a decidedly acid reaction, was brown in color, and was not disagreeable in smell.
>
> To ascertain the effect on the animal system of the liquid and the tincture above described, a number of frogs were procured for the experiment. About one half cubic centimeter of the liquid and the tincture each was introduced separately into the stomach. Neither the liquid nor the tincture produced any apparent effects. The vivacity of the frogs so treated continued unimpaired, notwithstanding the complete retention of the doses. Again two fresh frogs were submitted to a hypodermic injection of the liquid and the tincture, in the hind legs, by means of an ordinary hypodermic syringe. The injection of the distilled liquid was unattended by injurious results. A slight disinclination, at first, to use the hind limbs was shown also in the case of another frog, which was treated hypodermically with pure water to check the results obtained.
>
> The injection of the tincture, however, proved fatal to the subject. A few moments after the injection the leg operated upon seemed to become paralyzed, and the heart stopped beating within thirty minutes afterwards, by which time the other two hypodermically treated seemed to have completely overcome the effects of the operation.
>
> The tincture though highly concentrated, contained but a small quantity of animal acids. * * * The acids being found to be present in such small quantity, the conclusion is unavoidable, in the light of the present experiments, that the bugs are *not* poisonous.

The experimenters conclude that the reported cases of poisoning result rather from the arsenic used in destroying the insects, or from carbonous oxide produced by incomplete combustion when large amounts of the beetles are thrown into a fire. It is to be hoped that the experiments will be continued, 1st, because they by no means cover the whole ground; 2nd, because, so far, they admit of the opposite conclusion to which the experimenters arrived. Until we have learned what the active principle is which produces the physiological effect that has been well attested, and the precise conditions under which it acts, the experience recorded in my last report will go for more than such experiments. The active principle, as there stated, is most probably volatile, and the processes described in the above experiments very probably had the effect to liberate the poison. Boiling is well known to destroy many organic poisons in this manner or by decomposition, and the green tuber, the fruit and haulm of the common potato lose their poisonous qualities by being so treated. In obtaining tinctures, whether by percolation of the powdered material, or as described in the experiments, the poisonous principle may,

further, not be extracted: it may be coagulated by, or insoluble in the alcohol, and it is quite essential that we know the nature of the vessel employed.

In conclusion, the physiological effects of a poison may differ vastly as between cold and warm blooded animals; the tincture is admitted to have contained an acid (which may be the poisonous principle) and to have killed a frog; and the possible injurious effect of the fumes from burning the insects granted. I therefore find no reason to change the views expressed a year ago, and it is worthy of note that Prof. A. J. Cook of the Michigan Agricultural College, from experiments somewhat similar to those of Messrs. Grote and Kayser, has arrived at opposite conclusions to those which these gentlemen came to.

CANKER WORMS.

(Ord. LEPIDOPTERA; Fam. PHALÆNIDÆ.*)

In my seventh Report I illustrated and explained the differences in habit and structure between the Spring and Fall Canker worms which had been for so many years confounded. Further investigations during 1875 have enabled me to still more fully complete the comparisons there instituted, and have shown that the structural differences are greater than I had at first supposed. These differences led me to separate the insects generically, in a paper read last Fall before the St. Louis Academy of Science. The volume of Transactions in which this paper is published will not be given to the public for many months to come, and in order to lay the subject before the reader in succinct form, and at the risk of repeating much that has appeared in my previous reports, I here reproduce the paper *in extenso*, with only such alterations as are necessitated by the proper references to the figures.

REMARKS ON CANKER-WORMS AND DESCRIPTION OF A NEW GENUS OF PHALÆNIDÆ.

[Read before the St. Louis Academy of Science, Oct. 14, 1875.]

From the time when Wm. Dandridge Peck published (in 1795) his essay on the Canker-worm, which received a prize from the Massachusetts Society for Promoting Agriculture, up to the year 1873, all writers on the subject spoke of THE Canker-worm under the impression that there was but one species. Nevertheless two very distinct species have been confounded under this name. The first intimation we have of there being two species is where Harris—after describing at length, as THE Canker-worm Moth, not the species first called the Canker-worm by Peck, but the larger species (*pometaria*) here treated of—uses the following language: "Specimens of a rather

*Hybernidæ of Guenée.

smaller size are sometimes found, resembling the figure and description given by Prof. Peck in which the whitish bands and spots are wanting, and there are three interrupted, dusky lines across the fore-wings, with an oblique, blackish dash near the tip. Perhaps they constitute a different species from that of *the true Canker-worm moth.* Should this be the case, *the latter* may be called *Anisopteryx pometaria.*"* The portions of this passage which I have italicized are well calculated to mislead, for the term "true Canker-worm Moth," should only apply, in justice, to that described as such by Prof. Peck, and not, as Harris here applies it, to the other species. Indeed, most subsequent writers, including Fitch, Packard, Mann, and myself,† were misled by the language, and took it for granted that the name *pometaria* was proposed for the smaller form—a mistake first clearly pointed out by Mr. H. K. Morrison, of Cambridge.‡

So long as the male moths only were carelessly compared, there was always a question as to whether the differences were varietal or specific—1st, because the general resemblance is strong; 2d, because each species varies considerably both in size and ornamentation; 3d, because the wing-scales, especially of one species, easily rub off, and perfect specimens, captured at large, are uncommon. More careful comparisons made in 1873 by Mr. Mann (*loc. cit.*) between both sexes, established the specific differences of the two; and further comparisons, by myself,§ of the preparatory states, showed these differences to be still more remarkable than had been supposed. During the present year I have been able to make still more careful comparisons, which show the two insects to be so very distinct that they must be separated generically. These differences are set forth in the following comparative columns. They show that *pometaria* alone can be retained in the genus *Anisopteryx*, and for *vernata* I have, therefore, erected a new genus, *Paleacrita*.

Egg.

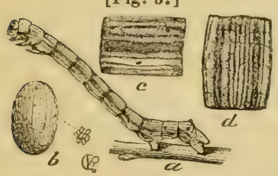
PALEACRITA VERNATA.

Elliptic-ovoid, the shell of delicate texture and quite yielding; generally appearing shagreened or irregularly impressed; nacreous, and laid in irregular masses in secreted places. (Fig. 3, *b.*)

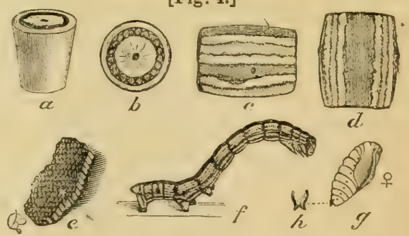
ANISOPTERYX POMETARIA.

Squarely docked at top, with a central puncture and a brown circle near the border; of firm texture, and laid side by side in regular rows and compact batches, and generally exposed. (Fig. 4, *a, b, e.*)

[Fig. 3.]



[Fig. 4.]



Larva.

PALEACRITA VERNATA.

No. prolegs on joint 8. (Fig. 3, *a.*)

ANISOPTERYX POMETARIA.

With a pair of short but distinct prolegs on joint 8. (Fig. 4, *f.*)

---

* *Insects Injurious to Vegetation*, 3rd ed. p. 462.

† *Vide* Fitch, Rep III, § 38; Packard's *Guide*, 3rd ed. p. 324; Mann. Proc. Bost. Soc. Nat. Hist., xv. p. 382, Riley; Mo. Rep. vi. p. 29.

‡ Proc. Bost. Soc. Nat. Hist. vol. xvi. p. 204.

§ 7th Mo. Ent. Rep., pp. 80-88.

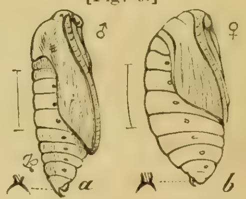
PALEACRITA VERNATA.	ANISOPTERYX POMETARIA.
Head distinctly mottled and spotted, the top pale, and two pale transverse lines in front.	Head very indistinctly spotted, and dark on top.
Body with eight superior, narrow, pale, longitudinal lines barely discernible. the two lowermost much farther apart than the others.	Only six superior, broad, and very distinct pale lines, those each side equidistant.
Dorsum pale, with median black spots; subdorsal region dark; stigmatal region quite pale.	Dorsum dark, without ornament; subdorsal region pale; stigmatal region dark.
Pilliferous spots quite visible and large on joint 11, where the pale lines generally enlarge into white spots immediately in front of them.	Pilliferous spots subobsolete.
When newly hatched *dark* olive-green or brown, with black shiny head and cervical shield.	When newly hatched *pale* olive-green, with very pale head and cervical shield.

Chrysalis.

Formed in a simple earthen cell, the earth compressed, and lined with very few silken threads so as to form a fragile cocoon, which easily breaks to pieces.	Formed in a perfect cocoon of fine, densely spun silk of a buff color, interwoven on the outside with particles of earth; never breaking open except by force or purpose.

[Fig. 5.]

[Fig. 6.]



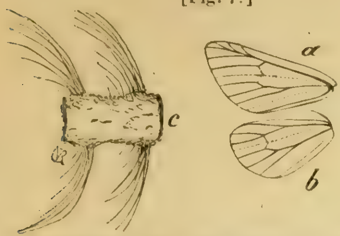
MALE—Sparsely and shallowly pitted. Pale grayish-brown, with a greenish tint on the wing-sheaths, which extend to the posterior edge of the 5th abdominal joint; abdomen with the spine at tip gneerally simple, and only occasionally slightly bifurcate.	MALE—Not pitted. Darker brown than *vernata;* the wing sheaths, as in *vernata*, reaching to the 6th abdominal joint; the anus more blunt and with the spine more dorsal, decurved, and always bifurcate, the prongs spreading and often long and fine. (Fig. 6, *a*.)
FEMALE—With wing-sheaths, but compared with those of the male, thinner and extending only to the posterior edge of the 4th abdominal joint: much more robust and more arched dorsally, with the mesothoracic joint shorter, and much reduced in size. Pitted like the male. (Fig. 5.)	FEMALE—Differs from the male in the same way as *vernata*, but is relatively stouter and more arched dorsally: a broad, dusky, dorsal stripe often visible toward the time of issuing—all the more remarkable that there is no such stripe on the imago, whereas in *vernata*, where the imago has such a stripe, it is not indicated in the chrysalis. (Fig. 6, *b*.)

Imago.

PALEACRITA VERNATA.

MALE—*Palpi* very short, but distinctly 2-jointed.

[Fig. 7.]



Antennæ with not quite 40 joints, the longest more than twice as long as wide, each with *two pairs* of hair fascicles, springing from very slight, lateral elevations, the longest hair about thrice the diameter of joint. Looking from above, with ordinary lens-power, these hairs give the appearance of fine, ciliate pectinations. (Fig. 7, *c*.)

Abdomen with the first seven joints bearing each two transverse dorsal rows of stiff, reddish spines, pointing posteriorily.

[Fig. 9.]

Wings delicate, silky, semi-transparent, transversely striate, the scales short and very loosely attached.

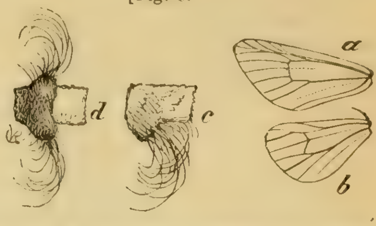
Front-wings with costal and sub-costal veins well united, with the discal cross-vein partially open, and but *two* short costal branches, the superior veins straight.* (Fig. 7, *a*.)

Upper surface brownish-gray.

ANISOPTERYX POMETARIA.

MALE—*Palpi* rudimentary with joints indistinguishable.

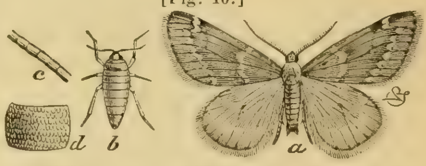
[Fig. 8.]



Antennæ with over 50 joints, the longest not twice as long as wide, each with *one pair* of fascicles of slightly curled hairs, the longest about thrice as long as the diameter of the joint, and all springing from a prominent, dark hump which occupies the basal half of the joint beneath, and gives a somewhat serrate appearance from the side. The same appearance of ciliate pectinations looking from above. (Fig. 8, *c*, *d*.)

Abdomen without spines and often with a moderate anal brush.

[Fig. 10.]



Wings less transparent, more glossy, not striate, the scales on an average longer and more firmly attached.

Front-wings with costal and sub-costal less closely united, with the discal cross-vein well closed, and with *three* costal branches. All the veins 7–11 are more distinctly separated and the superiors more curved, veins 9 and 10 forming an open areolet near the disc: the apex more produced. (Fig. 8, *a*.)

Upper surface also brownish-gray, but somewhat darker, with a purplish reflection.

*A microscopic examination shows the venation in *vernata* to be on the same plan as that in *pometaria*. The difference is that in *vernata* the costal vein is feeble and generally obsolete at its termination, and all the veins 7–12 are more closely united with the costal than in *pometaria*.

PALÆACRITA VERNATA.	ANISOPTERYX POMETARIA.
Crossed by three jagged, dark lines, sometimes obsolete except on the submedian and median veins, and on the costa where they are always distinct and divide the wing into four subequal parts. No white costal spot. (Fig. 9, *a.*)	Crossed by two less jagged, whitish bands, the outermost suddenly bending inward near costa, where it forms a pale, quadrate spot, relieved by a darker shading of the wing around it: the bands sometimes so obsolete as to leave only this pale spot; but more often relieved on the sides toward each other by a dark shade, most persistent on the veins. (Fig. 10, *a*)
A pale, jagged, subterminal band, corresponding in some degree to the outermost band in *pometaria*, but running out to apex, where it is always sharply relieved posteriorly by a dark mark, and often the whole length by dusky shadings.	No such band.
Hind-wings with the costal vein bifurcating at, or but little beyond, the discal, and with the independent or vein 5 faint. (Fig. 7, *b.*)	*Hind-wings* with the costal vein bifurcating considerably beyond the discal, which is strongly elbowed; vein 5 quite strong. (Fig. 8, *b.*)
Color pale-ash or very light gray, with a dusky discal dot.	Grayish-brown, with a faint blackish discal dot.
No white band, and rarely any marginal dots.	In most specimens a curved white band runs across the wing. and the veins inside this band and on hind border are generally dotted.
Under surface with a more or less distinct dusky spot on each wing, the front wing having in addition a dusky line along median vein and spot on costa toward apex. No pale bands.	*Under surface* with a dusky discal spot on each wing, and with the outer pale band on upper surface of front-wings as well as that of the hind-wings showing distinctly, the former relieved by a dusky spot inside at costa.
FEMALE—*Antennæ* generally with but few more than 30 joints, the longest about thrice as long as wide, faintly constricted in middle, and pubescent. (Fig. 9, *c.*)	FEMALE—*Antennæ* with over 50 joints, the longest hardly longer than broad; uniform in diameter; without pubescence. (Fig. 10, *c.*)
Body and legs pubescent, clothed with whitish and brown, or black, dentate scales or hairs; general coloration not uniform. Crest of prothorax and mesothorax black. A black stripe along the middle of the back of the abdomen, often interrupted on the second to seventh joints, with a whitish patch each side of its front end. (Fig 9, *b. d.*)	*Body and legs* smooth, clothed with glistening brown and white truncate scales intermixed, giving it an appearance of uniform, shiny, dark ash-gray: somewhat paler beneath. (Fig. 10, *b. d.*)
Abdomen tapering rather acutely behind, and with an exsertile, two-jointed, conspicuous ovipositor. (Fig. 9, *e.*)	*Abdomen* tapering rather bluntly behind, without exsertile ovipositor.

PALEACRITA VERNATA.	ANISOPTERYX POMETARIA.
Two rows of spines on back of the first seven joints more prominent than in the male, and often giving the dorsum a reddish aspect. (Fig. 9, *d.*)	No spines on abdomen.
Of a rather smaller size than *pometaria*, the wings of the male expanding from 0.86–1.30 inches, and the female measuring 0.20–0.35 inch in length.	The wings of the male expand from 1.05–1.35 inches; and the female measures 0.25–0.40 inch.

From the above detailed descriptions of the two species it is evident that, as already remarked, *pometaria* alone can be referred to the genus *Anisopteryx*, and this doubtfully. It agrees with the European species of the genus in the principal pterogostic characters, obsolete tongue, and rudimentary palpi; and is, indeed, the analogue of the well known *æscularia*. Yet in the antennal characters of the male, and especially in the basal hump on each joint, it agrees more nearly with the typical species of the genus *Hybernia* as characterized by Guenée. Again, so far as we now know, it differs from *Anisopteryx* in the additional pair of prolegs in the larva, and in the more distinct areolet in the front-wing. I can find no detailed account of the early states of any of the European species of the genus, though in none of the descriptions of the larva at my command is any mention made of additional prolegs. Mr. Geo. T. Porrit, who particularly describes the larva of *A. æscularia*,* makes no mention of this structural feature, and Guenée particularly says: "Il ne faut pas chercher des charactères pour les *Anisopteryx* dans les premiers états, car les chenilles ne diffèrent ni pour la forme, ni pour les couleurs, ni pour les mœurs, de celles des *Hybernia* du première groupe." Should future observations prove this statement correct, then the characters that belong to *pometaria* may come to be considered of generic value. For the present I deem it best to refer it to *Anisopteryx*, as more careful study will probably show that in the characters of egg, larva, and chrysalis, the European species of the genus agree with it, and that some of the structural features of the adolescent states have been overlooked in Europe, as they so long were in this country.

Paleacrita, nov. gen., approaches much nearer *Hybernia*, from which it is, however, readily distinguished by the double pair of hair fascicles to each ♂ antennal joint; the pubescent hairs that cover the female; the two-jointed, horny, exsertile ovipositor; but, more especially, by the dorsal abdominal spines in both sexes—all characters unmentioned in existing diagnoses of the genus.

One peculiar feature which I noticed in *pometaria* is that the larva molts but twice. Yellowish-white when first hatched, with the black eyelets showing distinctly on the pale head, it soon deepens to pale olive-green, and the three whitish lines each side show soon after birth. It develops very rapidly, often entering the ground within three weeks from hatching. The chrysalis is not formed till about a month afterwards, whereas *vernata* takes on this form two or three days after entering the ground.

The practical lessons to be drawn from the differences here pointed out between these two Canker-worms have been set forth in the report already cited. *Paleacrita vernata* rises from the ground mostly in early Spring, for which reason I have popularly designated it as the Spring Canker-worm. The principal efforts to prevent the female from ascending the tree should, therefore, be made at that season. The cocoon being fragile is easily broken by any disturbance of the land, and, as the chrysalis is more

* *Ent. Month. Mag.* (London) ix. 272.

liable to perish when the cell is broken, fall-plowing of the soil under trees that have been attacked by the worms is to be recommended. The eggs being secreted, for the most part, under loose bark, the scraping of trees in early spring, or any system of keeping them smooth, will act as a preventive of injury. *Anisopteryx pometaria*, which I have called the Fall Canker-worm, rises, for the most part, in the Fall, and should be attacked most persistently at this season. Its cocoon being tougher, and its eggs attached to smooth as well as rough trees, scraping and plowing will effect little in preventing its injuries.

Both species attack fruit and shade trees; but while *vernata* is common and very injurious in the apple orchards of the Western States, *pometaria* is rare there, and most common on the elms of New England.

These two insects, so long confounded, forcibly illustrate the practical importance of minute discriminations in Economic Entomology.

Thus, in addition to the characters pointed out a year ago, we have an important distinction between the two insects, from the practical stand point, in the manner in which the chrysalis state is assumed. The Spring Canker-worm, with its chrysalis formed in a simple earthen cavity, will be very materially affected by late fall plowing of the soil, especially if the soil be of such nature as to crumble easily; for I showed in 1869* that whenever the fragile cocoon is broken open, as it very readily is by disturbance of the soil, at that season the chrysalis has not the power to penetrate it again or to form a second cavity, and either rots, dries out, becomes moldy or, if on the surface, is devoured by birds. For the same reason the rooting of hogs is very beneficial in lessening the work of this species. With the Fall Canker-worm, on the contrary, these measures will avail little, if anything; for the cocoon, composed of a thick layer of yielding silk strengthened by the interweaving of particles of earth cannot be broken open by any such processes, and a dozen plowings would not expose a single chrysalis. Without doubt, we have in these facts a valid explanation of the contradictory experience as to the value of fall plowing or the use of hogs in an orchard as canker-worm checks.

In brief, all the more important measures to be pursued in our warfare against the Spring Canker-worm—such as the use of hindrances to the ascensions of the moths in spring; the removal of all loose bark and keeping the trunk and limbs as smooth and clean as possible; the employment of hogs, and fall plowing—are, in the main, useless as directed against the Fall Canker-worm which must be fought principally by traps or barriers *applied to the tree in the Fall* to prevent the climbing of the moths which mostly issue at that season. Important points like these cannot be too often insisted on, because I find that our horticultural writers yet very generally speak of THE

* 2nd Rep. 102.

Canker-worm as though there were only one species in the country, and give general directions which of course are more or less misleading. I find too that even where the differences pointed out have been recognized, they have not always been properly apprehended; so that in the report of a lecture before the Iowa Agricultural College it is erroneously stated that the Fall Canker-worm hatches in the Fall of the year, whereas, while the moths rise and lay their eggs at that season, these do not hatch any earlier than do those of the Spring species.

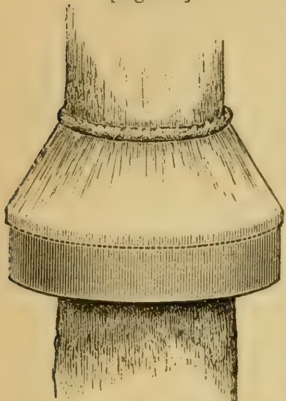
Of a number of the Fall species experimented on the past year, I obtained 58 chrysalides from larvæ that had been fed, some of them on Elm, some on Apple, some on Cherry and some on Peach. This last food was evidently relished least and rejected when the other three kinds could be had, but I perceived no preferences for any of the other kinds. A careful examination of the chrysalides in the Autumn showed that out of the 58, only two were males.* I divided the cocoons into two equal lots, placing the one lot in a covered flower pot out-doors, and retaining the other in breeding cages in-doors, so that the first would be submitted to the influence of frost and the other not. From Nov. 8, to Dec. 9, the moths issued almost daily—27 in all, namely, the two males and 25 females. An examination in January, 1876, showed that all the others had perished by rot, induced doubtless by the premature opening of the cocoons in order to examine the chrysalides. Those exposed to frost commenced issuing first, and a larger percentage of moths were obtained than from those kept indoors—which would indicate that a low freezing temperature followed by a thaw assists development, though by no means essential. The two males were placed in a separate, covered pot with five females that issued contemporaneously. Each of these five females was served, and each laid her full complement of eggs, four of them in single batches of 224, 230, 241 and 243 respectively, and the fifth in two batches of 142 and 63 respectively. The first four batches were laid on the smooth pine sticks that supported the muslin cap; the last two on the muslin. In each instance the time occupied in oviposition was between two and three days. None of the unimpregnated females laid regular batches. Most of them laid a few scattered eggs, generally in ones, but also in small groups ranging from 2 to 54.

Before concluding these notes I will add to the other contrivances that have been mentioned in previous reports descriptions from the

*Inasmuch as the larvæ were purposely poorly fed—the withholding of food having been carried to the extent that only the number mentioned entered the ground out of some 2,000 that were commenced with; the result is rather damaging to those who believe—if there yet be such—that the male sex can be produced in insects by stunting the larva.

"Illustrated Annual Register of Rural Affairs," published by Luther Tucker & Son of Albany, of two contrivances for protecting trees from this insect, that are unknown in Missouri, and that are very favorably spoken of by that careful horticultural writer, Mr. J. J. Thomas. The first is one successfully used by C. L. Jones of Newark, N. J.

[Fig. 11.]



Canker-worm Trap.

[Fig. 12.]

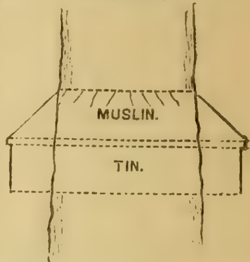
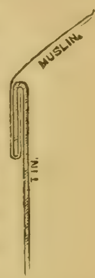


Fig. 11 is a view of the contrivance, which consists essentially of a band or circle of tin, a few inches outside the trunk of the tree, and held there by a circle of muslin, attached to the tin at its edge and drawn with a cord at the top, so as to fit the tree closely, and prevent the insects from getting up without going over the tin, covered with a mixture of castor-oil and kerosene, which as soon as they touch, they drop to the ground. Fig. 12 is a section of the contrivance, and Fig. 13 a section of the union of the tin and muslin, effected by turning over the upper edge of the tin before it is bent to a circle, inserting the edge of the muslin, and hammering them together. The tin may be about three inches wide, and long enough to rest three or four inches off from the trunk, when bent around in the form of a hoop, and secured by rivets or small tacks. After the tin and muslin are attached to the tree, the whole inner or lower surface of the tin is daubed with a mixture of equal parts of kerosene and castor oil. The tin and muslin entirely protect the oil from the sun and the weather, and it will not dry for several days. It will not run down, as the castor-oil thickens it. Of course it needs occasional renewal, with a small brush or feather. This protector is kept on the tree till the moths disappear.

[Fig. 13.]

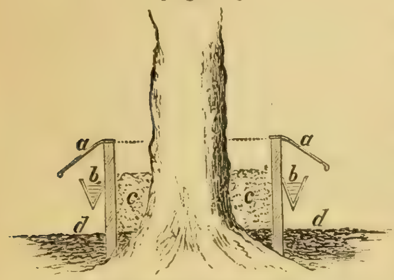


For those who wish to do work thoroughly while they are about it, and who believe that a little extra time and expense at the start is more than saved in the long run, I do not know that any better contrivance could be recommended. But I would remind the reader that even so perfect an "estopper" as this, may measurably fail, if directed solely against the moths. The worms that hatch below the trap, and which are more difficult to manage, must also be headed off; and I would insist in pursuance of this object, that, in addition to the above directions, the muslin be tied around the tree over a layer of cotton wadding, and that the contrivance be kept on the tree and the tin oiled, at least three weeks after the tree begins to leaf out in the spring. The eggs laid below the trap should, of course, be destroyed as far as

they can be, and such destruction in dealing with the Spring species will be facilitated by a bandage of rags below the trap or by anything that will afford the moth shelter for her eggs and that can be easily removed and scalded: where no such lure is used, an application of kerosene will prevent the eggs laid on the tree from hatching. But some are likely to be laid where they escape the closest scrutiny, and while the precautions I have indicated will insure against the ascent of such, whether from the Fall or Spring species; without those precautions some of the newly hatched worms which can pass through a very minute crevice or over the smoothest surface, may get into the tree; and though they may be so few in numbers as to attract no attention they nevertheless perpetuate the species in the orchard. The second contrivance is an old one that has been employed for nearly forty years in Massachusetts, and lately used with satisfaction by Mr. J. G. Barker of Cambridge.

Fig. 14 is a section of the whole contrivance—*a a* being the zinc roof over the oil troughs, *b b*; *d d*, the surface of the earth, *c c*, the tar or lime which is used to fill the box around the tree.

[Fig. 14.]



Canker-worm Trap—Section.

Fig. 15 is a smaller view of the same. The box is square—large enough to leave about four inches of space around the tree; is sunk some four inches in the ground, and rises about ten inches above the surface. The trough is in shape like the letter V, two inches deep, and is made by a tinman before nailing on the box; it is tacked on two inches below the upper edge of the box, and then the roof is placed in position and secured by a single screw into the upper edge of each side or board. It must, of course, be placed in a level position, to hold the oil. This is done by means of a spade used in setting the box in the earth. The box and roof are nearly completed in the tinshop, but the corner of both must be left open till placed around the tree, when the parts are soldered together. The roof is about four and a half inches wide, with the underside turned under about the fourth of an inch, to keep it stiff and in shape. In order to examine the oil, and to see that all is right, it is necessary to loosen one of the screws. The box will vary somewhat in size with the magnitude of the tree; with a trunk six inches in diameter, the box should be about fourteen inches square and fourteen inches high; for a trunk a foot in diameter, it should be about twenty inches square; but a variation of two or three inches would not be of great importance. A few inches of tanbark or lime placed within, is for the purpose of preventing the moths from ascending inside. One pint of crude petroleum (costing 3 cents per tree, at 24 cents per gallon,) is enough for each tree.

[Fig. 15.]

Canker-worm Trap.

With a little care in making a close connection between the v-shaped trough and the box, the above contrivance must work to perfection, as, indeed, Mr. Barker found it to do. Yet on account of the greater labor and expense of making and using it, and of the greater difficulty of examining beneath it, the first described is the preferable of the two. Indeed I should advise the use of Mr. Jones' contrivance, if kept properly oiled, over all forms of troughs whatsoever, for they too often get filled up with the dead bodies of the moths or with leaves, or get bridged with spider web; and where fastened directly around the tree must needs be renewed as the girth of the tree increases.

THE ARMY WORM—*Leucania** *unipuncta* Haw.

(Ord. LEPIDOPTERA; Fam. NOCTUIDÆ.†)

The insect which, next to the Rocky Mountain Locust attracted most attention and did most damage in Missouri during the summer of 1875, was the Army Worm. In its destructive power and sudden appearance and disappearance, it may be compared to the dreaded locust of the mountains; but everyone can see how this last comes and goes, upon its wings; whereas the coming and going of the Army Worm are more mysterious and not so well understood.

The species has already been treated of in my second Report; but the experience of six years has added much that is of interest to our general stock of knowledge of so remarkable an animal, and from the evidence adduced a year ago and published in the appendix to the Chinch Bug article, it is manifest that my second Report was very poorly distributed, and is not known to one in a thousand of the farmers of the State. I deem it advisable, therefore, to devote some space in the present Report to the consideration of the Army Worm, and in doing so, I may have occasion to reproduce, in quotation marks, a few passages from the previous article referred to.

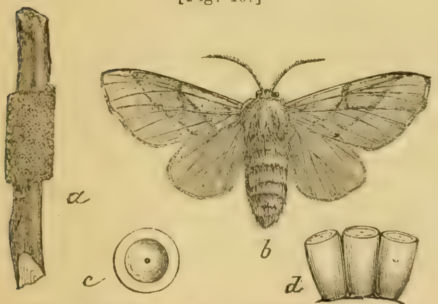
* *Leucanidæ* of Guenée.

† This long known and familiar generic term, applied to a well defined genus, has recently been dropped from our nomenclature—in the writings and in the "List" and "Check List" of N. A. Noctuidæ by Mr. A. R Grote. It has been replaced by *Heliophila* of Huebner. By this change we pass from light into darkness. I consider that the reasons so long urged by entomologists against the adoption of the classification of the "Tentamen" and "Verzeichniss," and particularly those given by Guenée for not following this last in his admirable work on the Noctuidæ, are good and sound. The Huebnerian classification is essentially unreal, and the generic divisions so inadequately defined that I doubt if any one would attempt to make use of the works in question, were it not for the references to the admirably illustrated works of the same author. The introduction of his generic terms into American Lepidopterology has so upset its nomenclature, without in the least advancing our knowledge, and the grounds for this introduction are so questionable, that those who make these insects a speciality are apt in the future to divide into two factions—the Huebnerites and the ante-Huebnerites; in which event the latter will certainly have strong support from entomologists in general.

THE TERM "ARMY WORM" APPLIED TO VARIOUS INSECTS.

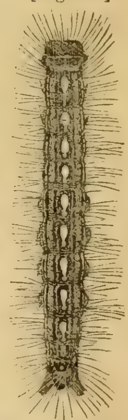
The name "Army Worm" is naturally given to any insect larva that congregates and travels in large numbers. Thus, in parts of Europe some of the owlet moth larvæ and particularly that of *Calocampa exoleta* (Linn.) sometimes go by that name; and on the Pacific coast another larva, which has not, so far as I can learn, been specifically determined, is often reported in the California papers by the name of "Army Worm," as doing great injury to the beet crops. "The Cotton-worm (*Anomis xylina*,* Say), is very generally known by the name of 'the Cotton Army-worm,' in the South. The term as applied to this species is not altogether inappropriate, as the worm frequently appears in immense armies, and when moved by necessity will travel over the ground 'in solid phalanx;' and so long as the word 'Cotton' is attached — its ravages being strictly confined to this plant — there is no danger of its being confounded with the true Army-worm. The term has, furthermore, received the sanction of custom in the Southern States, and of Mr. Glover in his Department Reports." The Army Worm of Jos. B. Lyman, in his "Cotton Culture" (p. 29) is what I have characterized as the Fall Army Worm (Rep. III, 109), an insect closely resembling the true Army Worm in larval appearance and habit, and which I shall presently have occasion to refer to again. The Tent Caterpiliar of the Forest (Rep. III, 121) is also frequently dubbed "Army-worm," a fact which is by no means surprising since it often appears in countless numbers and particularly in the more southern States, where it strips the oak forests for hundreds of square miles. In 1872 this species was so numerous around Memphis as to frequently stop the trains going in and out of the city. It stripped orchards, and great lanes of bare trees marked its track through the woods. Finally, the "Army Worm" of the Germans is what we more generally call "Snake Worm," viz., the larva of *Sciara* (a genus of small gnats) which has the peculiar habit of traveling in large

[Fig. 16.]



TENT CATERPILLAR OF THE FOREST: — *a*, eggs; *b*, female moth—natural size; *c*, egg, from top; *d*, from side—enlarged.

[Fig. 17.]



TENT CATERPILLAR OF THE FOREST.

* Identical, as Mr. A. R. Grote first pointed out, with *Aletia argillacea*, Huebn.

bands or armies, all the individuals attached to each other, heads to tails, and the whole mass moving with one impulse, as a unit.*

The species we are now considering is, however, the only one in America which has a just claim to the title, not only because it was first thus christened, but because it so well deserves the name. Known to the scientific world as *Leucania unipuncta*, and often called the Northern Army Worm, to distinguish it from the other species that have usurped its title, this insect has a very extended range and possesses immense power for harm on account of the importance of the crops it devastates.

PAST HISTORY OF THE TRUE ARMY WORM.

"If we trace back the history of the Army Worm in this country, we find that inaccuracy and confusion characterize most of the records concerning it previous to the year 1861. In that year, however, by the contemporaneous observations and experiments of several entomologists, in different sections of the United States, its natural

* These bands of small worms are of not unfrequent occurrence in Missouri, and I give herewith accounts of them from three different correspondents. In two of the instances the specimens have been sent to me and proved to be identical. The species averages 5½ mm. in length by 0.5 mm. in width, or about a quarter of an inch long and one-tenth as wide. It is a plain, pale-yellow, soft, viscid, semi-transparent, legless worm with a free and brown head, and a slight swelling around the anterior border of the abdominal joints; the body being cylindrical and tapering but very slightly towar l head. Normally these worms live huddled together under the decaying bark of trees, which they leave in adhering bands, when they are full grown and about to enter the ground to transform. When thus marching in trains they are usually pursued by numerous enemies, and especially by rove-beetles (*Staphilinidæ*) and ants. They have been reported from various parts of this country.

From my pear-trees runs a path to my stable. In said path, early this morning, we noticed what we first thought a snake just shed. On closer examination it proved to be a rope-like (about two feet long and ¾ of an inch thick) moving mass of minute worms such as we send you in the center of the enclosed tin box. Could have sent more than a pint. Afterwards in our fruit-garden we noticed apple trees much blighted; then some of our pear trees died of the same disease. We examined with a knife some of the shoots and found the track and in the track castings of what we thought just such fellows as those massed and marching away from our pear trees. We hastened to the moving rope: it had disappeared, and we could find no traces of the worms, except where they had been trodden into the mud. As we said, this moving column was leaving our pear trees (about fifty) that are dead and dying with blight. In the pear-limbs that we cut off between the outer bark and the wood, we found the track or burrow, castings, etc, and occasionally a worm of the color and size of these migrating bands. We send you with the worms some of the pear limbs from trees that were dying with blight. We never noticed this worm until last season, as above stated, and we had no blight until that time.

Will you please investigate the pear blight and tell us if there is any connection between it and these worms?

JOS. SMITH.

Stewardsville, Mo., June 16, 1870.

Of course, as I wrote to Mr. Smith at the time, there is no connection between the worms and the blight, other than that as soon as a tree is blighted, it furnishes under the decaying bark desirable food for them—they being rather the effect than the cause.

In July 1872, Mr. Louis S. Noce sent me specimens identical with those sent by Mr. Smith, with the statement that at Bismarck, Mo., they were travelling together in a roll the size of an ordinary snake.

The third communication about these snake worms in Missouri was made to me last summer by Mr. G. A. Bezoni, of Napoleon, Lafayette Co., under the impression that they might be the genuine Army Worm with which he was not familiar. The species was larger and evidently distinct from the others. He thus describes their appearance:

There were discovered here last summer two rolls of worms, one about six feet long and the other about four feet long They were as large as a large snake, and were traveling from the east. They were so compact and so shaped that they were mistaken for snakes. We got sticks and stones to kill them with, as they were crossing the road, but on striking we found that they were worms, of a grey color and about three-fourths of an inch long.

history was first made known to the world, and the parent moth identified.

"The very earliest record which we find of its appearance in this country is in Flint's 2nd Report on the Agriculture of Massachusetts, where it is stated that in 1743 'there were millions of devouring worms in armies, threatening to cut off every green thing.'

"In 1770 it spread over New England in alarming numbers. Dr. Fitch in his 6th Report quotes the following full and interesting account from the Rev. Grant Power's Historical Sketches of the Coös Country in the Northern part of New Hampshire. 'In the summer of 1770 an army of worms extended from Lancaster, the shire town of Coös county, N. H., to Northfield, Mass., almost the whole length of the Granite State. They began to appear the latter part of July, and continued their ravages until September. They were then called the 'Northern Army,' as they seemed to advance from the north or northwest to the south. It was not known that they passed the highlands between the rivers Connecticut and Merrimack. Dr. Burton, of Thetford, Vermont, informed the author that he had seen the pastures so covered with them, that he could not put down his finger without touching a worm, remarking that 'he had seen more than ten bushels in a heap.' They were unlike anything that generation had ever seen. There was a stripe upon the back like black velvet, and on each side a stripe of yellow from end to end, and the rest of the body was brown. They were seen not larger than a pin, but in maturity were as long as a man's finger and of proportionate thickness. They appeared to be in great haste, except when they halted to feed. They entered the houses of the people and came up into the kneading troughs as did the frogs in Egypt. They went up the sides of the houses and over them in such compact columns that nothing of the boards or shingles could be seen. Pumpkin-vines, peas, potatoes and flax escaped their ravages. But wheat and corn disappeared before them as by magic. Fields of corn in the Haverhill and Newbury meadows, so thick that a man could hardly be seen a rod distant, were in ten days entirely defoliated by the 'Northern Army.' Trenches were dug around fields a foot deep, as a defence, but they were soon filled and the millions in the rear passed on and took possession of the interdicted feed. Another expedient was resorted to: Trenches were cut, and thin sticks, six inches in diameter, were sharpened and used to make holes in the bottom of the trenches within two or three feet of one another, to the depth of two or three feet in the bottom lands, and when these holes were filled with worms, the stick was plunged into the holes, thus destroying the vermin. In this way some corn was saved. About the first of September the worms

suddenly disappeared. Where or how they terminated their career is unknown, for not the carcass of a worm was seen. Had it not been for pumpkins, which were exceedingly abundant, and potatoes, the people would have greatly suffered for food. As it was, great privation was felt on account of the loss of grass and grain.'

"The same writer adds that 'in 1781, eleven years after, the same kind of worm appeared again, and the fears of the people were greatly excited, but this time they were few in number.'

"In 1790 their ravages are again recorded in Connecticut, where they were very destructive to the grass and corn, but their existence was short, all dying in a few weeks (Webster on Pestilence, I, 272.)

"Their next appearance in the Eastern States was in 1817, after an interval of twenty-seven years, according to Fitch, who quotes the following paragraph from the Albany (N. Y.) *Argus*:

"*Worcester, Mass., May 22nd*, 1817.—'We learn that the black worm is making great ravages on some farms in this town, and in many other places in this part of the country. Their march is a 'displayed column,' and their progress is as distinctly marked as the course of a fire which has overrun the herbage in a dry pasture. Not a blade of grass is left standing in their rear. From the appearance of the worm it is supposed to be the same which usually infests gardens, and is commonly called the *cut-worm*. * * * This same worm is also destroying the vegetation in the northern towns of Rensselaer and eastern section of Saratoga, New York. Many meadows and pastures have been rendered by their depredations as barren as a heath. It appears to be the same species of worm that has created so much alarm in Worcester county, but we suspect it is different from the cut-worm, whose ravages appeared to be confined to corn.

"It was not until after a lapse of forty-four years from the last mentioned date, namely, in the summer of 1861, that this worm again spread over the meadows and grain fields of the Eastern States. During the interval, however, it had from time to time attracted attention in the Western States, where it often proved quite destructive. Thus, in Illinois, it is recorded as having appeared in 1818, 1820, 1825, 1826, 1834, 1841, 1842, 1845, and 1856, and according to Mr. B. F. Wiley, of Makanda, Ill., it was quite numerous and destructive in the southern part of the State in 1849, and appeared there also in 1857, though it was confined that year to limited localities.* Mr. J. Kirkpatrick, of Ohio, mentions its appearance in the northern part of that State in

Prairie Farmer, July 18th, 1861.

1855. He says: 'Last season (1855), in consequence of the heavy rains in the early part of June, the flats of the Cuyahoga, near Cleveland, were flooded. After the subsidence of the water, and while the grass was yet coated with the muddy deposit, myriads of small blackish caterpillars appeared; almost every blade had its inhabitant; no animal could feed upon it without, at every bite, swallowing several; if a new blade sprung up, it was immediately devoured, but what was most remarkable, the insects did not attempt to remove to land a foot or two higher, but that had not been covered by the water.' "*

Since the publication of my second Report I have learned through Mr. M. P. Lentz, of Rocheport, that it abounded in parts of Boone county, in 1854, and this is the earliest record that we have of it in Missouri.

"The year 1861 will long be remembered as a remarkable Army Worm year, for this insect was observed in particular localities throughout the whole northern and middle portion of the United States from New England to Kansas. It was first noticed in numbers sufficient to cause alarm, in Tennessee and Kentucky during the month of April; and toward the close of the same month it appeared in the southern counties of Illinois. By the end of June it had visited nearly all portions of the latter State, proving more or less destructive to grass, wheat, oats, rye, sorghum and corn.

"Its advent in Missouri was simultaneous with that in Illinois, and judging from what facts I have accumulated, it occurred very generally over this State, though recorded only in St. Louis, Jefferson, Warren, Boone, Howard and Pike counties. No mention is made of its occurrence, at this time, in any of the States or Territories west of Missouri, but to the East, scarcely a single State escaped its ravages. In many portions of Ohio it entirely destroyed the hay and grain crops, and in the eastern part of Massachusetts the damage done was reported to exceed a half million of dollars."

In 1865 and in 1866 it attracted attention in restricted localities in Illinois and Missouri. In 1869 it again appeared in vast numbers in many portions of our State, especially in St. Louis, Jefferson, Cooper, Callaway, Henry, St. Clair, Marion, Ralls, and Lafayette counties; also in some counties in Illinois and Indiana. The first intimation I received of its appearance in Missouri was the following letter sent to me by Mr. A. E. Trabue of Hannibal, under date of June 8th:

> I inclose a match-box with grass and two worms, which we think are Army Worms. They are here in myriads destroying the grass. Destroyed a hundred acres of blue grass meadow in five days, and are now advancing on me. What are they and their habits?

*Ohio Agricultural Report, 1855, p. 350.

Carbolic acid (one part acid, 20 parts water) kills them if they get a good drench with it, but is too expensive at that rate. They will cross a trail of it without injury, though they evidently dislike the smell. Have sent to town for coal tar to see if they will cross it when the ground is soaked with it. The advancing column is a half mile wide.

The hogs are very fond of them; will not notice corn when they can get Army Worms, but we have more of the latter than they can dispose of.

In 1871 it was reported in the *Prairie Farmer* "Record of the Season" from Marion and Morgan counties in Illinois, and was also abundant in Linn, Louisa, Washington, Appanoose and other counties in Iowa, according to the State Agricultural Report for that year. In 1872 it was more wide-spread, and I received specimens from several correspondents, in Iowa more particularly. It was reported in Louisa, Van Buren, Wapello, Jefferson, Muscatine, Jasper, Washington, Iowa and Adams counties in that State, and very generally in Wisconsin, in Ohio and in Kentucky. It attracted less attention in Illinois and Missouri, though I met with it frequently in the last named State. It was also reported from Tioga county, N. Y. Graphic accounts were likewise published of its devastations in Tennessee, and the *California Farmer* of July 25, 1872, reported legions of Army Worms as appearing over that State spontaneously, and 'stripping vines and potato fields.' From this last statement I infer that they were of some species other than the one we are considering.

But the most interesting manifestation of the insect during the year 1872 was in the vicinity of Peshtigo, in the northeastern portion of Wisconsin. It will be remembered that of the memorable fires that ravaged the northwestern country in the Fall of 1871, none, after that of Chicago, attracted more attention, or caused more sympathy for the sufferers therefrom, than that which swept through Peshtigo, destroying the whole town, and causing numerous deaths and great distress. During July of the following year the people of Peshtigo suffered another infliction in the shape of armies of worms that destroyed the crops and were so numerous that in many places they could be shovelled up by bushels, and fell into wells in such myriads as to render the water foul and useless. This case has such an interesting bearing on the insect's natural history that I shall revert to it again under that head. For the present it is only necessary to say that there can be no doubt as to the species, as specimens received by Dr. LeBaron and by myself showed it to be the insect under consideration. After 1872, until last year, the Army Worm attracted no unusual attention.

ITS HISTORY IN 1875.

During the latter part of May, or just about the time that there was the greatest consternation regarding the locusts, our papers con-

tained dispatches from various parts of Southern Illinois and Central Missouri to the effect that the Army Worm had appeared in countless millions, and was destroying the grain crops at an alarming rate. During the last week of that month Mr. C. M. Samuels of Clinton, Ky., brought specimens to my office with the statement that they were common and doing much damage all over the northwestern portion of Kentucky. It was also reported from various parts of Delaware and of Ohio about the same time. Somewhat later it appeared in Iowa, and I quote the following account of its advent at Fort Madison, from a letter from Dr. A. W. Hoffmeister:

The Army Worm was very troublesome in some localities near Fort Madison. About the first of June immense numbers of caterpillars, one-half inch long, were observed in low grounds, subject to overflow or standing water. Their eating created a noise which could be heard at a distance as a dull grating or sawing sound. About the 21—24 they bored into the ground and pupated, and in about two weeks after appeared as moths. I had caught the *Leucania unipuncta* in the fall of 1875 and spring of 1876 in great numbers by the process of sugaring, looking at both seasons very fresh; and therefore it is a riddle to me whether there is another brood or whether some pupæ remain dormant till fall or next spring. All my pupæ hatched, but I did not see the moths cohabit, nor did I find young or new larvæ during the summer. This fall the moths are less numerous than last fall.

During the latter part of July and August it attracted attention in New York, and by the middle of the latter month was swarming on Long Island. In September and October it was extensively reported in New England, where it did much injury to Hungarian grass and to oats. Mr B. P. Mann of Cambridge, Mass., who took the moth at sugar as late as October 27, sends me the following extracts which will show the time of year and the numbers in which they appeared in different parts of New England:

Army Worms are very destructive to vegetation around Mashias [Maine.] There has been nothing like them since 1861. * * * The Army Worms have appeared in large numbers at Colchester, [Conn.] and are doing much damage to the crops. [*Boston Daily Advertiser*, Aug. 10 and 11, 1875.

The Army Worm appeared in immense numbers on Sunday at Sussex, on the government railway line, east of St. John [N. B.], and since that time the ravages have created wide-spread alarm. Fields of grain have been destroyed. Horse rollers run over the road where they crossed did not perceptibly lessen their numbers. A dispatch from St. Andrews says, the Army Worm invaded that town yesterday, covering the streets, fields and lanes in every direction, and devouring the grass and grain in spite of every opposition. They are still advancing. [*Ibid*, Aug. 12, 1875.

A worm has been discovered in Hollister [Mass.] in such large quantities as to lead to the supposition that it may be the Army Worm again. The army has invaded Delham. They have devastated an acre of Hungarian owned by Mr. Greenwood Fuller, a large field of grass for Mr. Luther Fisher; also for Mr. L. Baker. [*Ibid*. Aug. 16, 1875.

The south shore [of Mass.] in the vicinity of Black Rock has of late been visited with an innumerable host of moths, commonly called millers. They took possession of rooms which were accessible by the windows being left open, in such numbers that it was the work of days to rid the rooms of their presence. Their origin is a mystery; but they entered rooms facing north in such flocks that it is a theory that they came in from the sea. In one small room 800 were killed. [*Ibid*, September 3, 1875.

ITS HISTORY IN MISSOURI IN 1875.

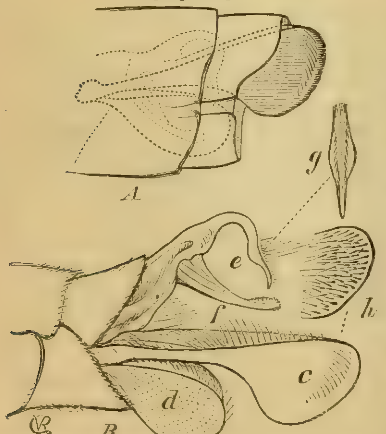
The most noticeable feature connected with the appearance of the worm in our own State was its harmlessness, or non-appearance in the western or locust-stricken portion. Most of these counties are large stock-raising counties, and abound in rich prairie and good meadows. Under ordinary circumstances, the worms would have flourished there; but last spring, though I have records of their appearance, the locusts either destroyed them or caused them to starve before they acquired full growth. The following list of counties in which no Army Worms were noticed or in which they were soon killed out, is made up from reports from my correspondents, and very forcibly illustrates the feature referred to: Andrew, Barton, Benton, Buchanan, Bates, Barry, Caldwell, Clay, Clinton, Cass, Cedar, Daviess, Dade, Dunklin, Grundy, Gentry, Henry, Harrison, Hickory, Holt, Henry, Jackson, Johnson, Jasper, Lafayette, Linn, Marion, McDonald, Macon, Newton, Oregon, Pulaski, Pettis, Putnam, Ray, Sullivan, Scotland, St. Clair, Texas, Taney and Vernon.

In nearly all of the counties not mentioned I have records of its appearance, and often in such numbers that whole fields and meadows were cut down.

SEXUAL DIFFERENCES.

As throwing light on the mode of oviposition the sexual characteristics interest us. The sexes at first glance are not easily distinguished. There are no colorational differences, nor does the abdomen of the one sex differ materially in size or form from that of the other. Yet a careful examination with an ordinary lens will enable one to separate them with sufficient certainty by the smoother antennæ (Fig. 22. *e*) and more pointed abdomen (Fig. 22, *b*) of the female compared to the more hairy or ciliate antennæ (Fig. 22, *d*) and blunter abdomen of the male (Fig. 22, *a*). The antennæ of the female will generally be found quite naked toward the base, while those of the male show two rows of stiff hairs, about half as long as the antennal width. In both sexes the tip of the abdomen is covered with a

[Fig. 18.]



Genitalia of Male Army Worm Moth:—*A*, end of body, denuded of hairs, showing the upper clasps protruding, and the natural position of the hidden organs by dotted lines; *B*, the organs extruded.

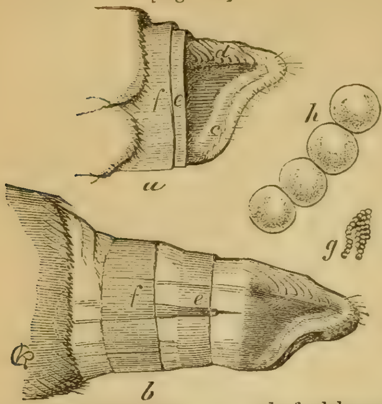
brush of long pale hairs, and the moment these are brushed away the sex is at once easily ascertained. Suppose now we pick out a male for examination! A little friction with a stiff camels hair brush will soon denude the tip of the abdomen without injuring the horny parts, when we shall notice two rounded, brown, horny lobes or clasps extending somewhat beyond the ultimate joint (Fig. 18, *A*) the lobes some distance apart below, but converging until they touch, above. A careful removal of the chitinous exterior of the two terminal joints will further reveal to us that these lobes are but parts of a somewhat complicated arrangement, admirably adapted for seizing the female, and consisting chiefly of the two lobes referred to, of two smaller, inferior lobes, and of two intermediate organs starting from a knotty base, the upper one curved and ending in a sort of beak, the lower one more straight and ending in a small cushion of contracted membrane above.

A still more careful examination will show that the upper valves (Fig. 18, *c*) have a rather long and gradually narrowing stem, and that they broaden irregularly, the hind border obliquing beneath and the lower border more strongly curved than the upper: all the borders are thickened, the outer surface is polished and dark brown and the inner surface is clothed with stiff, pale, decumbent hairs, replaced toward the posterior portion with brown, retrose spines. (Fig. 18, *h*). The lower valves (Fig. 18, *d*) have a shorter stem and are more regularly rounded: each is composed of two corneous layers soldered and somewhat thickened at the borders, the outer piece easily fractured and detached, pale and covered sparsely with very minute spines; the inner one more solid, darker, and covered with a dense brush of long pale hairs. The upper, intermediate, curved organ reminds one from the side of a swan's neck and head (Fig. 18, *e*): it is yellowish and cylindrical, dilates and enlarges toward the end and terminates in a narrower darker beak, the sides of the dilatation behind are curled up (Fig. 18, *g*) and furnished with long yellowish hairs behind, and the beak with a brush of shorter hairs. The lower organ or penis (Fig. 18, *f*) is broader, composed of membrane supported by two principal ribs—the upper one curved, the lower nearly straight—and ends in a sponge-like, superior swelling, which in life may be considerably extended in the form of a tube. Both those intermediate organs play on a strong horny arch which is generally retracted, but which can be raised and exserted and considerably dilated as in Fig. 18, *B*.*

If we now take a female and denude the tip of her abdomen in the same way, we shall immediately find a quite different and far more simple structure, namely, a thin vertical blade-like valve, more or less produced or elongated on the upper portion, of a brown color, but with a broad, slightly thickened, paler border. This valve plays

* A careful examination of the genital organs of thirteen ♂s of this species shows very considerable variation in the contour, and relative size of all these different parts—so much so as to convince me, when added to my limited examinations of the same parts in other species, that nice differences in these parts alone are of no specific value.

[Fig. 19.]



ARMY WORM MOTH:—*a*, end of abdomen denuded and showing ovipositor at rest; *b*, same with ovipositor fully extended; *e*, *f*, retractile subjoints; *h*, eggs—all enlarged; *g*, eggs, natural size.

into two retractile subjoints of the body, and may be hidden within the terminal joint proper, so as to show only the upper tip, or extended as in the figure (Fig. 19, *a*). It is in reality composed of two thin layers, closely appressed except at the upper or dorsal portion near the base, where it swells into a somewhat angular ridge outside and is hollow within. A more careful examination will show that the upper portion is irregularly and obliquely striate (Fig. 19, *d*), the striations representing folds of the membrane, to facilitate expansion; and that the hind border is garnished with fine hairs which easily rub off and leave the edge quite sharp, so that the two layers form a blade which is admirably adapted to pressing in between narrow passages, or even to splitting frail and hollow stalks. In life this ovipositor plays on the two sub-joints which may be greatly extended, and when so extended forms a somewhat cylindrical and telescopic tube which is rendered very firm by a series of stout muscles within. (Fig. 19, *b*). The valve opens from top to bottom, and may be very considerably distended so as to make way for the oviduct which is a quite complicated structure.

NATURAL HISTORY OF THE ARMY WORM.

Up to the year 1861 our knowledge of the natural history of the Army Worm had remained a blank. Nothing, indeed, of a scientific nature had been published respecting it. "A few very observing farmers ventured to predict its appearance during very wet summers succeeding very dry ones. They did not know why this was the case, but it was a fact that they had learned from experience. It was also known that the worm attacked only the grasses and cereals, that it was gregarious in its habits, and that it disappeared suddenly, in a manner as seemingly mysterious as that in which its advent was supposed to have been made."

In 1861, however, its wide spread occurrence over the country and the large amount of injury it caused, attracted the attention not only of farmers, but of several well known writers on economic entomology and agriculture. Among these may be mentioned my late friends B. D. Walsh, of Illinois, and J. Kirkpatrick, of Ohio; and Prof. Cyrus Thomas, of Illinois, Dr. Asa Fitch, of New York, and J. H. Klip-

part, of Ohio. Through the efforts of these gentlemen the worm was for the first time connected in our minds with the parent moth, and several parasites were ascertained to infest the species. But beyond these points—important as they are—no discoveries were made. The complete natural history of the species has yet to be recorded. Where facts are wanting theories flourish, and we find that in the *Prairie Farmer*, the *Illinois Farmer*, the *Field Notes* and the *Ohio Farmer*, some very spirited articles were published in 1861 by Messrs. Walsh, Klippart and Thomas — the controversy between the first two being at times personal and acrimonious. The points of dispute between Messrs. Walsh and Thomas were, 1st, whether the insect winters in the egg or chrysalis state; 2nd, whether it is single or double brooded—Mr. Walsh arguing for the first of both propositions. From an economic view these points are of vital importance, and though they have not yet been settled by direct observation, I shall endeavor to settle them, as far as it is possible, by deduction from the known facts in the case that bear on them. Before attempting to do so, it will be well to briefly describe the Army Worm in the three states in which it is known.

[Fig. 20.]

Full grown Army Worm.

"The general color of the full grown worm is dingy black, and it is striped longitudinally as follows: On the back a broad dusky stripe; then a narrow black line; then a narrow white line; then a yellowish stripe; then a narrow sub-obsolete white line; then a dusky stripe; then a narrow white line; then a yellowish stripe; then a sub-obsolete white line; belly, obscure green. (Fig. 20.)

"The chrysalis (Fig. 21) is of a shiny mahogany-brown color, with two stiff converging thorns at the extremity, having two fine curled hooks each side of them. The general color of the moth is light reddish-brown or fawn color, and it is principally characterized by, and receives its name from, a white spot near the center of its front wings, there being also a dusky oblique line running inwardly from their tips. The accompanying illustration (Fig. 22), will show wherein it

[Fig. 21.]

Chrysalis of Army Worm.

[Fig. 22.]

ARMY WORM MOTH:—*a*, male moth; *b*, abdomen of female—nat. size; *c*, eye: *d*. base of male antenna; *e*, base of female antenna—enlarged.

differs from the Southern Cotton Army-Worm, notwithstanding the colors of the two moths are nearly alike. Our Army moth was first described by the English Entomologist Haworth in the year 1810, in his *Lepidoptera Brittanica*, page 174, as *Noctua unipuncta*. Subsequently the French Entomologist Guenée (*Noctuiètes* I, p. 77) overlooking the former's description, and regarding it as a new species, named it *Leucania extranea*. Of course Haworth's name takes the precedence. It is considered a common species even in European collections, and Guenée mentions it as occurring in Brazil. A variety without the white spot occurs in Java and India, and still another, lacking the white spot, and having a dark border on the hind wings, occurs in Australia; while an occasional specimen has been captured in England. A figure is given in Stainton's Entomologist's Annual for 1860, of one captured there in 1859, but if the figure is a correct one, the specimen is much lighter than ours, and the characteristic white spot is not nearly so conspicuous."*

Whenever this moth is noticed to be unusually abundant in Fall or Spring, the worm may be looked for in the early summer following, and the preventive measures that will be subsequently indicated should be more particularly adopted on such occasions. As of over a hundred correspondents of whom I have asked whether or not they are acquainted with this buff-colored moth, all but six have answered in the negative, and some few have even supposed the Tachina-flies that accompany the worms to be the parents of the latter; I have made a new figure (Fig. 22, *a*) which with the above description will enable the reader to recognize it.

DESCRIPTION OF THE EGG.

An examination of the egg as disclosed in those moths which have the ovaries fully developed, shows it to be spherical, smooth or but very faintly shagreened, with no ribs or sculpture whatsoever. The shell is quite delicate and semi-transparent, apparently of a dirty white or yellowish color. It measures 0.5 mm. in diameter, or about three-hundredths of an inch. In the abdomen these eggs are so closely pressed together in rows (Fig. 19, *g. h.*) that they often present two flat sides from the pressure. I have counted upward of two hundred in a single female, so that the species is quite prolific.

WHERE ARE THE EGGS LAID?

Omne vivum ab ovo—Every creature springs from an egg! Not only from analogy, but from the universality of the law expressed in the foregoing phrase, we could safely conclude with absolute certainty that our Army Worm comes from an egg, even if I had not just dem-

*Mr. Herman Strecker, of Reading, Pa., informs me that he has specimens from New Zealand and Australia, undistinguishable from ours.

onstrated the fact. Further, we may conclude with sufficient certainty that the egg is laid by the parent moth and hatches outside her body. Analogy would also indicate that it is laid on the insect's preferred food-plants; it being a very general law in insect life that the parent, with wonderful instinct, commits her eggs to the plant on which the larvæ or young are destined to feed, if these are herbivorous by nature. Analogy is not, however, an infallible guide, here, for we have seen in the case of the Fall Army Worm that the parent frequently deposits her eggs on the leaves of deciduous trees, which leaves the worms do not feed upon, but from which, upon hatching, they instinctively descend, so as to get at more congenial herbage below (Rep. III, p. 114). Yet there are many recorded facts and observations which indicate that the Army Worm moth follows the more general rule, and that she commits her eggs to the stalks of perennial grasses and of cereals, whether these be cut or still standing.

Nevertheless, the fact remains that no one has ever seen the eggs of the Army Worm moth, naturally deposited;* and even if we admit the correctness of the last conclusion, it still remains conjectural as to whether they are laid within or upon the stalks, single or in masses, in the Summer, in the Fall or in the Spring. Nothing but direct observation will fully and satisfactorily answer these questions; though we may by proper scientific method come to pretty safe conclusions regarding them.

Alive to the importance and interest attaching to these questions, I made every provision last summer that I deemed necessary to their settlement. But "the best laid schemes o' mice and men gang aft a-gley!" Having to leave for Europe just as the worms were entering the ground to pupate, I gave full and explicit directions to my clerk, Mr. Otto Lugger, for carrying on the requisite experiments and observations, with instructions to spare neither time nor means in pursuance of the object in view. The insect was abundant on many farms in St. Louis and Jefferson counties, and everything seemed propitious for fruitful observations. Mr. Lugger proved, by extensive breeding of the moths and attempts to obtain the eggs in-doors, that which I have repeatedly proved in previous years, viz: that the eggs cannot be so obtained. Beyond that, his work was fruitless; for unfortunately the rains in June and July were so frequent and copious, as to materially hinder out-door observations. Search for the moths in fields where the worms had swarmed a few weeks before was so vain as to

*The only purported description of the eggs is by Mr. S. P. Fowler, in a letter to F. W. Putnam, quoted by Mr. C. A. Shurtleff of Brookline, Mass., (Proc. Essex Ins. Vol. III) in his "Report on the Army Worm;" and which evidently refers to *Microgaster* cocoons.

lead to the belief that the insects must have been in great part, if not entirely, drowned out in this locality. In default of direct observation, let us see to what conclusion a careful study of the structure of the insect will lead us.

At first view it seems singular that the eggs of an insect that appears in such countless myriads from Maine to Georgia, and from Virginia to Kansas, should have remained undiscovered either by farmers or entomologists. Desiring to attract attention to the subject I offered in the columns of the *Prairie Farmer*, last September, a reward of $20,00 to any one who would send me the eggs of the insect; but no one claimed the reward. One of the obstacles that has stood in the way of discovering these eggs is that, as soon as the worms have multiplied so prodigiously as to attract attention, their natural enemies become so multiplied that a very small per cent. of the worms entering the ground issue again as moths. A second reason is that, during seasons when the insect is not numerous and attracts no attention, no one thinks of searching for these eggs. A third reason is that, as already stated, the moth does not oviposit in confinement. I venture to suggest a fourth probable reason that has, hitherto, occurred to nobody: it is that the eggs are, for the most part, secreted where they are not easily seen. Structure is an infallible index to habit. Look whichever way we may, in studying organic life, we find perfect adaptation of means to ends—special organs to special purposes. To approach at once the subject under consideration, we find the ovipositors of insects, or rather the external parts that shield and guide them, modified in a thousand ways to fit them for conveying the eggs to their destination. Look at the piercing and boring and stinging instruments of the Ichneumons, extending in some instances as in Rhyssa, several inches from the tip of the body! Look at the more or less perfect saws of the Saw-flies which insert their eggs in the tender stems or in the parenchyma of leaves of many plants! Examine the ovipositor of the Cicada and of many of our tree-hoppers, and see how admirably they are adapted to splitting and puncturing twigs! The slender-bodied Dragon-flies belonging to the genera *Æschna* and *Agrion* have an instrument springing from the base of the penultimate joint, composed of four slightly curved horny pieces, the outer pair sharp and notched near the tip, and the inner pair both striate and serrate, so as to perform the three offices of awl, saw and file—the whole admirably adapted for puncturing the stems of water plants. The female of the common Plum Curculio has, lying beneath the pygidium a beautiful horny exsertile spoon-shaped contrivance, with a decurving point, wherewith to guide her egg beneath the skin of the

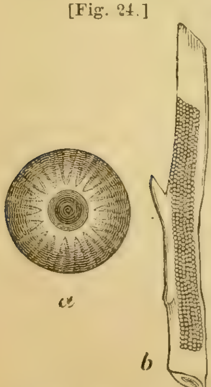
punctured fruit. The reader of these reports needs not to be told how admirably the ovipositors of the different Katydids are adapted to splitting the thin edge of a leaf, to penetrating a twig, or to rasping the same, according to the manner in which the eggs are laid; nor need he go beyond the case of the locust, with her drilling valves for an example of the same admirable adaptation. To come to moths, let me illustrate by a few examples taken alike from these reports. Mark the sword-like sheath and the extremely acute, wirey, elastic, thread-like organ (Rep V, Fig. 74, *j*) which is to convey the egg of the Yucca Moth to its destination through the tender flesh of the forming fruit: the horny, telescopic process (*ante* fig. 9, *e*) that enables the Spring Canker Worm Moth to thrust her eggs into cracks and cavities and beneath close-lying scales of bark! The ovipositor of the Stalk Borer (*Gortyna nitela*, Rep. I, Fig. 35) which in the larva state burrows in the stem of the Potato and of a variety of other plants, ends in a pair of horny nippers which open laterally (Fig. 23.) When closed they form a wedge which seems admirably adapted to prying between a terminal leaf bud or into the tender union of leaf with stem, and it is more than probable that the eggs are so placed. That of the Fall Army Worm, the eggs of which are laid in exposed masses and covered with down, is a mere fleshy, slightly bifid protuberance, generally hidden altogether out of sight in a dense mass of soft scales and down, which fills the end of the abdomen and which is easily detached and used in oviposition by merely rubbing against the surface on which the eggs are being laid, and perhaps also by the use of the bifid ovipositor for that purpose. In detaching the rather abundant pale hair that adorns the end of the abdomen outside, one is surprised at the profusion of black and gray downy matter that crowds the inside.

[Fig. 23.]

OVIPOSITOR OF GORTYNA NITELA:—*a*, showing it excerted from tip of abdomen; *b*, showing it from above.

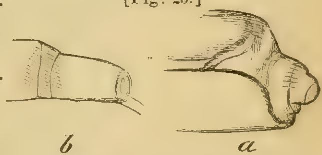
If we examine that of the parent of the Variegated Cut-worm—the Unarmed Rustic (Rep. I, p. 72,) the eggs of which (Fig. 24) are exposed and not protected with any covering, we shall find that it also is a mere fleshy, retractile tubercle (Fig. 25) capable of slight elongation. This last may be taken as an example of the typical form of ovipositor in all moths

[Fig. 24.]



EGGS OF UNARMED RUSTIC:—*a*, top view; enlarged; *b*, a batch natural size.

[Fig. 25.]



OVIPOSITOR OF UNARMED RUSTIC:—*a*, as it appears at end of abdomen; *b*, when extended.

which lay their eggs unprotected in exposed places; and wherever there is any great modification of it, we may feel sure that it is for some special purpose, and indicates some other than the ordinary mode of oviposition. Now if we study the structure of the ovipositor of *Leucania* as exhibited on page 32, we shall find that it is admirably adapted either to clasping the edge of a grass-blade or of a slender glass-stem, and attaching the eggs in rows therealong, or still better to pressing in between and then widening long and narrow passages, such as occur between the sheath and stalk of grasses and grains, especially just above the joints. It might even be used for splitting the more fragile, yielding and hollow stalks of grain, and of some of the tame grasses, though it evidently could not be inserted into the more solid and pithy stalks of most wild grasses. It is my belief, therefore, that the eggs of the Army Worm are secreted for the most part between the sheath and stalk of its food plants just above the joints. European observations do not help us much in forming any opinion; for the eggs of no species of the genus seem to have been observed. The fact is well known, however, that the larvæ of those species which frequent more particularly aquatic grasses and reeds, often retreat and live within the stems; while other insects of the same family, and notably those of the very closely allied genus *Nonagria* naturally live within the stems of reeds and flags. I find upon examination of such European species as I have been able to observe (*impura* Albin and *lithargyria* Esp.) that the ovipositor is constructed after the same plan, as are also those of our other American species of the genus; the difference, when there is any, being in the more pointed upper portion and lesser prominence of the rounder, lower portion of the valve. These facts lend some further weight to the deductions I have drawn.

There are many good reasons, also, for believing that perennial grasses are preferred by the moth, and that the eggs are seldom consigned to the stalks of annuals. From about 130 practical and intelligent farmers living in different parts of Missouri, to whom I have directly put the question: "What is your experience as to where the eggs of the Army Worm Moth are laid?" the large majority reply that they have made no observations and have no knowledge. A number give it as their opinion (and it is undoubtedly a correct one) that the eggs are laid in grass that has not been pastured and in old meadows; a smaller number that they are laid in oats stubble; still others that they are laid in old straw stacks; and a few that they are laid in the ground in sheltered and moist places. These opinions are

founded not on any direct observations on the eggs, but on the localities from which the worms were noticed to come last spring; and as the experience of some of my correspondents on these points is interesting, I give a few extracts herewith:

First noticed on low and level land—[Dr. A. H. Dye, Lamar, Barton county.

On level land; the opinion prevails here that they were most numerous on land that had been previously cropped to oats or Hungarian grass—Wm. H. Avery, same place.

First noticed in old meadows—[S. S. Smith, Bertrand, Mississippi county.

My opinion is that they originate in wet meadows—[J. M. Anthony, Fredericktown, Madison county.

In every instance, so far as we have been able to observe in this neighborhood, they came from the stubble near and among the roots of the grass in meadows; and they were noticed about the roots of the grass when as small in diameter as the finest needle—[Robt. E. Caskie, Rocheport, Boone county.

All whom I have spoken to describe them "to seem to just come out of the ground in *old meadows*, regardless of high or low situation." In some instances they came from old straw stacks, 2 years old.—[Wm. Riehl, Potosi, Washington county.

There were some Army Worms in a few localities in low meadow land in this and the east edge of Callaway county.—[E. R. Brown, Montgomery City, Montgomery county.

The worms hatched in low meadows first, and afterwards on higher lands, such as meadows and wheat fields, and in some instances they hatched in fields planted in corn.—[Henry Bruihl, Appleton, Cape Girardeau Co.

On low land.—[S. S. Bailey, Dundee, Franklin Co.

Noticed on both high and low, but were far more numerous on low meadow lands. No prairie here. They seemed to come from wheat straw cut in June and trashed in October; timothy cut in June and July, old dead weeds, and trash of all sorts that had lain over winter seemed their native home. Pastures or meadows pastured bare previous Fall, were not infested.—[Wm. Carr, Belleview, Iron Co.

They were first observed on high land and appeared in our flower garden, where we had used considerable straw and trash as a mulch.—[W. S. Goodman, Mt. Vernon, Lawrence Co.

On the farm of Mr. Henry Elliott, joining my wheat, are extensive Timothy meadows and old pastures of the same of twenty years standing, all of which were ruined so far as the then growing crop was concerned. Certainly they must have been bred in those meadows and pastures; if not, I know not from whence they came. High and low lands were alike infested. A few seemed to start from woodland pastures where stock fodder had been fed twelve months before, making their way into growing corn near by. This I observed in two places half a mile apart.—[Thos. Mitchell, Boonville, Cooper Co.

I think their appearance as a general thing was first in low lands, but in a very short time they spread over the hill lands as though they all came up out of the ground at once. They were most destructive near old straw piles.—[J. B. Douglass, Columbia, Boone Co.

In every old hay or straw stack place there were more or less of them, and to such an extent did they come from such places, that such places were fired to destroy them. On our place there were but few, and those from hay stacks; the hay was cut the latter part of the June preceding.—[L. A. Brown, Boonsboro, Howard Co.

There were none noticed on the upland in this county, but they were very numerous on creek bottoms in the southern part of the county.—[D. P. Dyer, Warrenton, Warren Co.

A piece of my farm was adjoining a straw rick, some of which was from the crop of '73, some from '72, and I am thoroughly convinced that the Army Worm has its origin

in old straw piles. Many fine meadows in the county were entirely destroyed by them, and in every instance, upon inquiry, I found they could be traced to the old ricks of straw contiguous to the meadows. They would pass from meadow to meadow, going through fields of wheat, eating only the cheat.—[F. M. DIXON, Jefferson City, Cole Co.

They invariably hatch in low lands or in or about old straw yards and low prairies. They do not seem to inhabit high lands, or visit them as frequently as low grounds.—[ELIHU CANADAY, Jones City, Pettis Co.

The above experience accords with that of a large number of persons who have observed the insect in years past; and from it we may conclude, 1st, that the moth lays her eggs in standing grass and grain stalks, but also in such as have been cut and made into stacks and ricks.

WHEN ARE THE EGGS LAID?

This question can only be answered in a positive manner when that we have just been considering is definitely settled. Nevertheless, we have facts enough to warrant our drawing conclusions with sufficient confidence. Practically the knowledge of the time of deposition is almost as important as that of the place. There have been, and can well be, but two opinions, viz., that they are laid either in the Spring or in the Fall. Every one who has had anything to do with the rearing of this moth or who has given any attention to it, knows that in the latitude of St. Louis, it issues on an average in from two to three weeks after the worm enters the ground. In this latitude they may be taken abundantly at sugar, from the middle of June to October. During all this time they may be noticed, when abundant, in our pastures and meadows, and especially in such as are rank and undisturbed. They have a strong flight, and in alighting dash down into the grass, apparently without any caution, and from observations which Prof. Thomas made last summer, it would appear that they mostly fly close to the ground and ascend but a few feet, since, though they were common about his residence, none reached his bed-chamber on the second floor. My own experience accords with this. The most interesting feature about this moth in the present connection, is that the ova are without any appreciable development at the time of issuing, for which reason, as I have already stated, I have always been unable to obtain eggs in confinement. By pressing the abdomen so as to extrude to their utmost the telescopic joints on which the ovipositor plays, the ovaries will issue from the lower part of the valve in the form of two little white sacks. A week after the moth issues the eggs are only just discernible in these sacks, like so many little specks all very regularly and beautifully arranged.

In order to throw light on the question under consideration, I have dissected and carefully examined a large number of female

moths from different parts of the country, and would right here tender my thanks, for their readiness in furnishing material from the localities where they reside, to the following gentlemen: A. J. Packard, Jr., Salem, Mass.; H. A. Hagen, Cambridge, Mass.; J. A. Lintner and Otto Meske, Albany, N. Y.; Hermann Strecker, Reading, Pa.; A. W. Hoffmeister, Fort Madison, Iowa; A. Bolter and O. S. Westcott, Chicago, Ills., and Cyrus Thomas, Carbondale, Ills. The result of these examinations proves that several weeks must elapse from the time the moth first appears before she can lay eggs. I have found these fully developed in only three specimens, one obtained of Dr. Hagen, and captured in Maryland (time not known) and two taken by myself in St. Louis county, in the month of September. They have fair development in some of the specimens taken during the same month in Chicago and New York, whereas in most of the specimens I have examined—many of them taken as late as August and September in Iowa, New York and Massachusetts—the eggs have been found very immature. This has likewise been the case with the few that I have been able to examine that were captured in the Spring. I am inclined to think that this is owing to the fact that most of the specimens in the cabinets of entomologists are fresh specimens, either bred in-doors and killed soon after issuing, or taken at sugar. There can be little doubt that the moth lives several weeks, or even months. Its tongue is very stout and by it the moth can perhaps obtain nourishment from the moisture and juice from the tender base of grass stalks,* as well as from the nectar of flowers. It naturally seeks rank grass plots, swamps or prairies, and once there would hardly be attracted to timber where sugaring is generally carried on.

In my second Report I stated my belief that in this latitude the bulk of the eggs are laid in the Fall of the year, and only the exceptional few in the Spring. This opinion was based on a large amount of testimony that might be cited to show that the worm never hatches the same year on land that was ploughed late in the Fall or in the Spring, or in grass or grain sown in Spring,† and that where meadows or grass plots have been burned in winter, they have been exempt from the ravages of the worm, while non-burned and adjacent grass has swarmed with it; also on the further fact that, so far as my experience goes, the moths are more numerous in the Fall than in the

* The Germans apply the term "honey-sweating" to some grasses.

† The testimony on these points is conclusive, as any one can see by carefully perusing the Report which B. D. Walsh published on the insect in the Transactions of the Illinois Natural History Society for 1861. In 1875 the same facts were observed, and Mr. C. M. Samuels, of Clinton, Ky., reports to me that all over that country where the worms were bad in May, they came from low grass lands, and that they never occurred on lands broken the previous Fall, though often abounding right along side, on unbroken lands.

Spring. But upon reflection we shall find that the first class of evidence does not preclude their being laid also in Spring; for if, as I believe, the moth oviposits by choice in mature grass, hay and stubble, the burning and plowing of fields would equally deprive her of the favorite nidus. The greater scarcity of the moths in Spring may, also, only be apparent, and due to the fact that they are more busy ovipositing. From the examination of over 50 females caught in the Fall—only 3 of which had well developed eggs—as well as from the many other considerations brought forward in this article, I am now more inclined to believe that the bulk of the eggs, even in this latitude, are laid in Spring, or early in the growing season, and that the smaller proportion are laid in the Fall. That such is the case further north, is pretty certain. The further north we go, the fewer eggs will be laid in the Fall.

Exceptional and abnormal occurrences often help us very materially in such questions as these. The remarkable appearance of the worm, as already described (*ante*, p. 28) in and around Peshtigo, Wisconsin, in the year following the memorable fires that swept over that country in October, 1871, was very interesting in this connection. The conflagration was very general, and occurred so late in the season as to preclude the idea that the eggs were subsequently laid that same Fall. It is barely possible that many of the eggs may have escaped, for though in some places the heat was sufficient to cook potatoes two or three inches under ground, in others grass and grain in low places, though scorched, were not materially injured, and these are just the places were the Army Worm eggs are most likely to be laid. But after taking much pains to get at all the facts, I believe that the Peshtigo experience proves conclusively that in that higher latitude the bulk of the eggs are laid in the Spring. The following letter from Mr. A. J. Langworthy, of Milwaukee, is interesting as giving particulars and dates:

The worm appeared about the 1st of July, and originated on the low, swampy lands, soils evenly burned, which abound in small patches all over the burned district. The territory burned over was before the fire at least three-fourths woodland, and a comparatively wild country, with no prairie at all. No part of the country invaded by the worm escaped the disastrous conflagration, which did its work on the 9th of October, 1871, at night, at the same time with the Chicago fire, and was followed by moderate rains very soon after, which extinguished most of the burning embers. By the 20th November following winter had set in with snow which did not disappear in the woods until the following April. I should say that the ravages of the worm about Peshtigo were confined to an area not exceeding 4 by 6 to 8 miles—and that they originated on the low grounds that had been formerly covered with a dense growth of white cedar, which is the case in all these swampy indentations. * * * Not *one-half inch* of rain had fallen in the doomed territory, from the 1st of May until after the fire in the Fall, so that the extraordinary drouth may have been favorable to the propagation of these insects. The worms in their line of march, through the "sugar bushes," a little west of where the village of Peshtigo stood, devoured everything in their course, even to the corn and onions, filling the wells, houses and barns of the few inhabitants, and driving them in dismay from beyond their presence.

We may justly conclude, therefore, that the disputants who have been contending, on the one hand for the Fall and on the other for the Spring oviposition of the Army Worm Moth, have, as in so many other cases of like nature, both been right and both been wrong. They were looking at the same shield from opposite sides. I am very much inclined to believe that whether the moths preponderate in Spring or Fall, even in the vicinity of St. Louis, depends much upon the character of the seasons. A large experience in rearing insects points conclusively to the fact that a certain amount of moisture is requisite for the proper development of all species that transform in the ground in a simple cavity; and that during excessive drouth pupæ so situated will remain dormant and unchanged for weeks, when a single moistening of the ground will revive them, permit the retarded transformation and release the imago from its parched prison.

IN WHAT STATE DOES THE INSECT HIBERNATE?

This question is intimately connected with the preceding one, and, like it, will not admit of a single unqualified answer. Accepting as facts that the eggs are laid both in Fall and Spring, the following questions are to be considered: 1st, whether the eggs laid in Autumn hibernate as such, or whether the larvæ first hatch and hibernate while small; 2d, whether those laid in Spring are by moths which issued at that season, after hibenating as chrysalides, or by such as issued the preceding Fall and hibernated as moths.

As bearing on the first question it is interesting to note that the European species of the genus, so far as their habits are known, hibernate in the larva state. Thus *Leucania lithargyria* Esper, and *L. turca* (Linn.) hibernate as young larvæ, while *L. comma* (Linn.) winters as a full grown larva, according to Speyer. Quite a large proportion of our closely allied cut-worms are, also, known to thus hibernate. It would seem, therefore that, in default of direct observation, we have no good reason for assuming that the eggs laid in Autumn necessarily hibernate as such. But while these analogies make it probable that the insect may winter in the larva state, all the other facts point to the conclusion that the proportion that so winter, if any, is very small. Instead of abounding in a wet Spring when their favorite haunts are overflowed, they would be well nigh drowned out, on the hypothesis that they had been wintering there as larvæ. As bearing on the second question we have certain facts which indicate that some of the pupæ hibernate, the proportion doubtless increasing as we go north. I have myself never had any of the worms remain in chrysalis through June, but Prof. Thomas records that less than half of the pupæ which he caged hatched out, and that "only a part are

transformed to moths during the season of their larva state."* Unfortunately he has left no record of rearing the moths from those chrysalides the following Spring, and we do not know to how large a degree the non-issuance of the moths was owing to unfavorable conditions in the breeding cage, which so often affect insects reared in confinement, and which every rearer of insects is so familiar with. But Mr. Otto Meske, of Albany, N. Y., informs me that he once found a chrysalis about the middle of May which in a few days gave him the genuine *unipuncta*, and the earliness of the date precludes the possibility of the worm having been hatched the same Spring in that latitude, and renders it almost certain that the pupa hibernated. Of more value still is the earliness of appearance and freshness of most of the moths captured in Spring—indicating that they have just come from the ground. These facts might, it is true, be explained by the larva hibernating partly grown, but the Peshtigo experience is valuable here and renders the other conclusion much the most plausible. In fact the hibernation of a certain proportion of the pupæ finds its parallel in numerous other instances in the lives of moths that might be mentioned. Every experienced entomologist is aware that with lots of species the imagos from the same batch of larvæ often issue partly in Fall, partly in Spring; while I have given instances in previous reports of still greater irregularity. The worms that attract such attention, about the time our wheat is ripening by marching from field to field are mostly full grown. These would naturally soon turn to moths; but it must not be forgotten that they are the earliest developed and that the younger and weaker ones have mostly been obliged to succumb in the struggle for individual mastery, which must have preceded the forced abandonment from sheer hunger, of the original fields where they were born; and that, further, in fields and rank places where the worms are not so numerous as to be obliged to travel, there are individuals maturing for several weeks after the more noticeable hordes have vanished out of sight. As to the hibernation of the moth, having shown that the larger proportion of the moths captured in Autumn have the ovaries yet quite immature, it is pretty evident that the insect hibernates in this state, and I learn from Mr. Strecker, that he has in fact, found the moth in February, hibernating under clap-boards at Reading, Pa., while Mr. B. P. Mann, of Cambridge, Mass., has also found it hibernating. It would be unreasonable to assume that such large numbers of the moths as occur in Autumn are destined to perish without issue. Moreover, a large number of closely allied moths are known to hibernate, and this mode of hibernation

* *Illinois Farmer*, Sept. 1861, pp. 271 & 272.

will explain more of the known facts in the insect's economy than any other.

From the foregoing considerations I think we may safely conclude that—taking our whole country with its varied climate—there is no one state in which the Army Worm can be said to solely pass the winter; that according to latitude and the character of the seasons, there is nothing to preclude its hibernating in any one of the four states in which it exists; that in the same latitude and under the same conditions it will even hibernate in different states; and that, finally, the great bulk of them hibernate in the pupa and moth states, the proportion of the former increasing northward.

HABITS OF THE WORM.

The fact cannot be too strongly impressed on the mind, that the traveling of the worms in large armies is abnormal. During the latter part of April and throughout the month of May, in this part of the country, the worms may almost always be found by diligent search in moist grass land that was not cut or grazed too closely the previous Autumn. At these times they have essentially the habits of ordinary cut-worms, and are seldom noticed unless so abundant as to cut the grass entirely down and be obliged to travel to fresh pastures. Indeed, one may pass daily through a grass plot where they abound, and never suspect their presence until the plot suddenly begins to look bare in patches; and Prof. Thomas tells me that though he was particularly looking for the worms last June, he never suspected their presence in a constantly frequented grass plot behind his house, until it was made manifest in this way, by which time the worms had mostly disappeared, the abundance of their excrement, however, showing well enough that they had been there.

The reasons why they so easily escape detection in this their normal condition, were made very obvious to me in the early part of May, 1872, when I had an excellent opportunity of studying them. When less than half an inch long, the worms are scarcely recognizable as Army Worms, the characteristic dark, sinuous lines on the head being at this time obsolete and the general color being pale green. The color is very variable at any stage of growth, and in some individuals the brown predominates while they are yet quite small; but up to the last molt the green generally prevails and the longitudinal dark lines are less conspicuous. The broad stigmatal line is the most persistent, being distinguished when the insect is ¼ inch long. The worms in this their normal condition feed mostly at night and hide during the day at the base of the grass or under any other shelter at hand. If they venture to mount a plant and feed during the day—which they often do in cloudy weather—they drop at the least dis-

turbance, and curl up in a spiral so as to simulate very closely a small shell of the *Helix* form. The worm loves cool, moist places, and is more often found around the margins of creeks and ponds than elsewhere. Last year when the rains were so copious as to fill creeks and bottom lands and float numbers of the worms away, I saw many an one cling tenaciously to grass blades and continue feeding as though little concerned, even when partly immersed.

As already intimated, it is only when hunger impels them that they march forth from the fields where they were born, though after they have once begun the wandering habit they often pass through fields without eating everything to the ground. Invariably when the older individuals are attracting attention by congregating and traveling in armies, others may be found of all sizes in the more normal and quiet condition in grass that is yet sufficiently rank: they may indeed be found some time after the first worms have changed into moths; and the mower with his scythe often startles the moths in numbers during the latter part of June, while yet the worms are clinging to the grass that he is cutting, or hiding in the stubble that he leaves.

When traveling the worm " will scarcely turn aside for anything but water, and even shallow water-courses will not always check its progress; for the advance columns will often continue to rush headlong into the water until they have sufficiently choked it up with their dead and dying bodies, to enable the rear guard to cross safely over. I have noticed that after crossing a bare field or bare road where they were subjected to the sun's rays, they would congregate in immense numbers under the first shade they reached. In one instance I recollect their collecting and covering the ground five or six deep all along the shady side of a fence for about a mile, while scarcely one was seen to cross on the sunny side of the same fence."

While most of the worms burrow into the ground and form a simple cavity a few inches below the surface, in which to undergo their transformations, many of them transform beneath loose stones, slabs of wood, matted grass, or any other shelter afforded.

TIME OF APPEARANCE OF THE WORM.

As this varies according to the character of the season and according to latitude, the only safe general statement that can be made is that the bulk of the worms are full grown and do the greatest damage about the time that " wheat is in the milk." This is also the time when they first attract attention as, though they hatch three or four weeks earlier, they are previous to this time not easily noticed for reasons just stated. In ordinary seasons they are reported along the 32nd par-

allel, as in Texas, early in March, and about a week later with each degree of latitude as we advance northward. Thus in South Missouri they commence to march about the middle of May; in Central Missouri the first of June, and in the extreme northern part of the State about the middle of the month. In the more northern New England States they seldom do much damage before the middle of July. There may, therefore, be a difference of over two months between the appearance of the worms in Southern Missouri or Kentucky and in Maine. Thus early in June of the present year, when I left home, they were mowing down the meadows and wheat fields in Central Missouri and in Southern Illinois, Ohio, Indiana, as well as in Kentucky; while upon arriving in New York two months later, they were marching through the oat fields of Long Island, and were reported very generally in the Eastern States. In Maine they appeared as late as September.

ARE THERE ONE, OR TWO BROODS EACH YEAR?

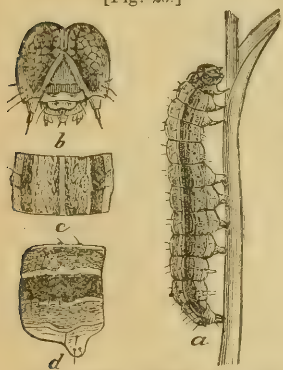
All the evidence, and the whole history of the insect as here set forth, point to its one-brooded character, at least in ordinary seasons, and north of the 38th parallel. In the more northern States, it is evident, from the lateness of the season when the worms enter the ground, that those which issue as moths the same season cannot beget a second brood, since the ovaries are so immature at the time of issuing. There is in fact no actual evidence of its 2-brooded nature. One of the arguments brought forward in support of the theory, is that it is difficult to conceive how an insect that produces but one brood annually can become at times so prodigiously multiplied. But it is only at long and irregular intervals that it does become so prodigiously multiplied, and after such a wide-spread appearance of it in our cultivated fields as that of 1875, it takes several years of undisturbed and unnoticed multiplication, culminating in unusually favorable conditions, before the decimation of its ranks that inevitably follows such undue increase, is repaired, and this notwithstanding its great prolificacy. It is an interesting fact, also, that most Lepidopterous insects that have a wide geographical range and the peculiarity of appearing suddenly and at irregular intervals in vast swarms, are known to be single-brooded; while most of our cut-worms, its close allies, I have by experiment proved to be so. The second argument in support of the 2-brooded nature of our Army Worm is, that accounts are often heard of the Army Worm appearing in the Fall of the year, but in every instance where I have been able to obtain specimens for examination, they have proved to be

THE FALL ARMY WORM.

This worm not only acts at times like the Army Worm proper, but bears a very close general resemblance to it, so that it is not surprising that the two insects should have been so often confounded. Reports of the appearance of THE Army Worm in the Fall, such as that recorded by Prof. Thomas, and which greatly influenced him in his belief that our Leucania was double-brooded,* are easily explained by what we now know of this Fall species. Having already given an extended account of this last in my 3rd Report,† it will suffice in this connection to repeat the leading facts in its history, so as to show how it may be distinguished from the Leucania.

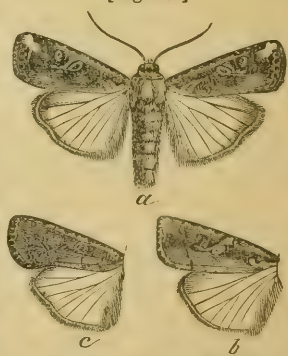
The Fall Army Worm—unlike the Leucania, which confines itself for the most part to grasses and cereals—is a very general feeder, devouring with equal relish most succulent plants, such as wheat, oats, corn, barley, grasses, purslane, turnips, most garden vegetables, and even spruces. Though variable in color, when carefully examined it will be found to invariably differ from the Army Worm in the following more noticeable points: 1. It never becomes quite so large; 2, the head is smaller, darker, with a conspicuous white, V-mark, not possessed by Leucania; 3, the lateral dark and pale lines are broader and the former bordered above by a much more distinct white or yellowish, narrow line; 4, the piliferous spots and hairs, which in Leucania are so obsolete that the worm appears perfectly smooth, form conspicuous polished black tubercles that give rise to short, stiff, black hairs. Compare figs. 20 and 26, *a*. Thus, whenever worms are found mowing down grain in the Fall of the year, the presence of these easily observed black tubercles will at once show that they are not the genuine Army Worm. The moth, which belongs to Guenée's Family

[Fig. 26.]



FALL ARMY WORM:—*a*, full grown worm, nat. size; *b*, head, from front; *c*, joint of body, dorsal view; *d*, do.. side view—enlarged.

[Fig. 27.]



FALL ARMY WORM MOTH:—*a*. the typical form; *b*, *c*, variations of wings.

**Prairie Farmer*, Nov. 7, 1861.

†This insect was there described as *Prodenia autumnalis*. Further investigation shows it to be the "Corn-bud worm moth" of Smith & Abbott, (Ins. of Ga., 96) figured by them as *Phalæna frugiperda*, and subsequently described by Guenée under the genus *Laphygma*, which is separated from *Prodenia* by a few rather trifling characters.

Apamidæ, is totally unlike our Leucania, being smaller, and of a mouse-gray color, with the hind wings glistening-white. Though so variable that scarcely any two are alike, they may yet be separated into three distinct sets or varieties. The first which may be considered typical is shown at Figure 27 *a*, the second which I have called *fulvosa* at *b*, and the third which I have called *obscura* at *c*. The eggs are deposited in small clusters, often two or three layers one above the other, and covered with downy hair from the parent's abdomen. Each egg has the form of a slightly compressed spheroid, faintly ribbed, and is dull yellow in color. As already stated (p 35) they are often laid on the leaves of trees on which the larva does not feed.

PLANTS PREFERRED BY THE ARMY WORM.

Though when hard pushed the worms will fall upon and devour each other, and—if the Peshtigo reports in 1872 are reliable—will take even onions, and other vegetables, and, according to B. F. Wiley, of Makanda, Ills., who is reliable authority, the leaves of fruit trees;* yet their attacks are mostly confined to grasses and cereals, and it is extremely doubtful whether they could live for any length of time on other plants. Their more natural food-plants are the coarse swamp grasses. Of cultivated crops they do most injury to timothy and blue grass meadows and winter wheat. Though they nibble at clover, they evidently are not fond of it and generally pass it by. Rye is also not as palatable to them as some of the other grasses.† They often cut off the ears of wheat and oats and allow them to fall to the ground, and they are perhaps led to perform this wanton trick, by the succulency of the stem immediately below the ear. South of latitude 40° they generally appear before the wheat stalks get too hard, or early enough to materially injure the crop; but north of that line, wheat is generally too much ripened for their tastes, and is sometimes even harvested before the full grown worms make their advent.

The worm sometimes passes through a wheat field when the wheat is nearly ripe, and does good service by devouring all the chess and leaving untouched the wheat; and the following items would indicate that even a foe to the farmer as determined as this, may sometimes prove to be his friend.

HARVEST AND CROPS.—Notwithstanding the unfavorable weather, many farmers have commenced the wheat harvest. The yield in this immediate vicinity will be superabundant. Some fields were struck with rust a few days since, but the Army Worm making its appearance simultaneously, stripped the straw entirely bare of blades and saved the berry from injury. These disgusting pests have saved thousands of dollars to farmers in this neighborhood. A few fields of corn and grass have been partially destroyed, but by ditching around fields, the worm's ravages have been confined

* *Prairie Farmer*, July 18, 1861.

† Jno. Monteith, the present Secretary of the Board of Agriculture, had two acres of timothy, sown in 1874 with rye. The worms last year cleaned out the timothy, but did not materially affect the rye.

within comparatively narrow limits.—[Collinville, Ills., correspondence of *Missouri Democrat*, June, 1869.

Mr. Ed. Dixon informed us Saturday that the Army Worm had destroyed twenty acres of timothy for him. From the meadow they entered the wheat field, and destroyed every stalk of cheat, leaving the wheat unhurt. Mr. Dixon ditched between his wheat and corn-field, and with the aid of a dozen or two pigs succeeded in arresting their progress and destroying them. This is about the experience that many farmers have had in this county. They can be prevented from doing harm by determined, vigorous opposition.—[Jefferson City *Tribune*, June 16, 1875.

The habit of merely stripping the blades off the wheat stalks was very general last summer, and a large number of farmers report that the work of the insect was beneficial to wheat, as the rains were very constant and copious and the grain denuded of its leaves ripened better than it otherwise would have done.

ITS SUDDEN APPEARANCE AND DISAPPEARANCE.

Among the manifestations in lower animal life, few are more astonishing than the sudden occurrence of a species in vast numbers over large stretches of country, and its as sudden disappearance. In a few rare instances, as with the thirteen and seventeen-year Cicadas, these manifestations are strictly periodical, and occur at regular intervals; but in the great majority of instances they have no such periodicity. The numerous natural checks which surround every animal, added to the meteorological conditions which affect it in its "struggle for existence," sufficiently explain these phenomena to the intelligent naturalist, though it is not always easy to point out the facts in specific cases.

Under the head of "Habits of the Worm," I have already given the reasons why it escapes attention in its earlier stages and in seasons when it is not excessively abundant. If, as from what has gone before we may justly conclude, the natural abode of the worm is in our low prairie lands and swampy places, it follows that during a very dry season, when such lands dry out, the worm has a wider range than usual, where the conditions for its successful development are favorable.

It is a well established fact that all great Army Worm years have been unusually wet, preceded by one or more exceptionally dry years; and the wide-spread appearance of the insect in 1875 formed no exception to the rule. The explanation of this fact originally given by Dr. Fitch,* is beyond doubt correct in the main, but needs further elucidation. Dr. Fitch's views, in his own words, are given in the following paragraphs:

The Spring and early summer of this year [1861] was exactly the reverse of last year—unusually wet, and the water high in all our streams. Hereby the swamps have all been overflowed, and this insect has been drowned out of them. [1] The moths or millers on coming out of their chrysalides, found it was impossible for them to get to the roots of the grass there, to deposit their eggs. They were obliged to forsake their usual haunts and scatter themselves out over the country, the incessant rains making it sufficiently wet everywhere to suit their semi-aquatic habits. Thus going forth in

* 6th N. Y. Rep., 121.

companies, they alighted in particular spots, and there dropped their eggs; and the result is sufficiently well known.

More briefly expressed my view is this: a dry season and dry swamps multiplies this insect. And when it is thus multiplied, a wet season and overflowed swamps drives it out from its lurking place [2] in flocks, alighting here and there over the country. But on being thus rusticated, it finds our arable lands too dry for it; and immediately on maturing and getting its wings again, it flies back to the swamps, whereby it happens that we see no more of it.

[1] It stands to reason that if the insect were drowned out by overflowed swamps, a wet season, instead of being favorable to its wide dispersion, would check its increase and almost annihilate it: what is meant is, doubtless, that the moth is driven out of the overflowed swamps.

[2] This necessarily implies that the moths either issue in the Fall, and winter over, or else in the Spring before the rains have overflowed the low places; for if the overflow take place while yet the pupæ are in the ground or after the eggs are laid or the worms hatched, it must needs prove detrimental by drowning them out. Thus, to state the explanation more explicitly, the conditions most favorable to the widespread appearance of the Army Worm in our cultivated fields and meadows are one or more dry seasons that will permit it to multiply in swampy places that are ordinarily overflowed, followed by a wet Spring in which the rains are not copious enough to overflow such places until the bulk of the moths have issued, and which soon afterwards are copious enough to overflow the low lands and oblige the moths—both those issuing in the Fall and in Spring—to lay their eggs on higher land which they ordinarily would not prefer.

The insect is with us every year and often attracts considerable attention in restricted localities the year preceding its more general advent. I have reared the moths from the worms on three different occasions since the last general appearance of the species in the West in 1869.

In the normal cut-worm-like condition they easily escape the eyes of man; but when the bulk of them have passed through the last molt, or, in other words, are nearly full-grown, and have stripped the fields in which they were born, they are then obliged to migrate in bodies to new pastures. Thus assembled and exposed, they pass through grass and grain-fields, devouring as they go; for they are now exceedingly voracious, and, like most Lepidopterous larvæ, consume more during the last few days of worm-life than during all the rest of their existence. The farmer who is unfamiliar with their life-habits wonders where they come from so suddenly, and presently, when they enter the earth to transform, he wonders again where they go to. In these exposed numbers, also, the numerous natural enemies of the worms congregate about them and do their murderous work far more

effectively than when they have to seek individuals hidden here and there in rank grass; so that we cease to wonder at the almost total annihilation of the species the year following its advent in such numbers. Moreover, while a certain amount of moisture is most congenial to them, excessive rains and storms such as we had last summer, and such as are likely to occur after excessively dry years, must inevitably destroy large numbers—floating many away into rivers, and causing others to rot on and in the ground. Man, too, in his warfare with them on such occasions, destroys great quantities; and, finally, only the vast armies on our cultivated lands disappear so suddenly, numbers remain unobserved in unfrequented and uncultivated grass land.

NATURAL ENEMIES.

"Hogs, chickens and turkeys revel in the juicy carcasses of the worms, and sometimes to such an extent that, as I am informed by Mr. T. R. Allen, of Allenton, the former occasionally die in consequence, and the latter have been known to lay eggs in which the parts naturally white, would be green when cooked. Small birds, of various kinds,* and toads and frogs also, come in for their share of this dainty food; while the worms, when hard pushed, will even devour each other."

[Fig. 28.]

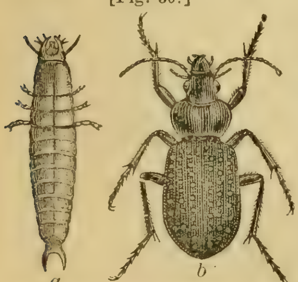
PASIMACHUS ELONGATUS.

[Fig. 29.]

HARPALUS CALIGINOSUS.

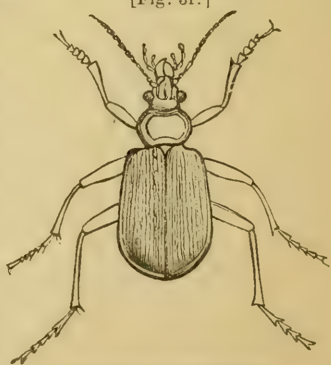
A large number of predaceous beetles gather around and about the travelling hordes and greedily prey upon them. Ten different species have been detected by myself and others in this work,† some of the principal of which are herewith illustrated. The worms have also an unusual number of true parasites. They never abound or travel from one field to another, but they are accompanied by a

[Fig. 30.]



CALOSOMA CALIDUM, with larva.

[Fig. 31.]



CALOSOMA SCRUTATOR.

* The Rice Bunting *(Doliconyx orizivora)* more particularly has been observed to feed upon them.

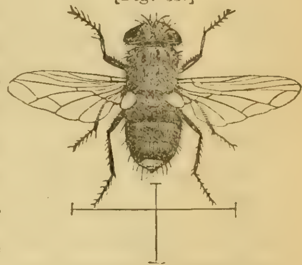
† *Cicindela repanda* Dej., *Elaphrus ruscarius* Say, *Calosoma externum* Say, *C. Scrutator* (Fabr.), *C. calidum* (Fabr.), *C. Wilcoxi* Lec., *Pasimachus elongatus* Lec., *Amara augustata* Say, *Harpalus caliginosus* (Fabr.), *H. pennsylvanicus* (Deg.)

number of two-winged flies which are often so numerous that their buzzing reminds one of that of a swarm of bees. The Red-tailed Tachina-fly (*Exorista leucaniæ*, Kirk, Fig. 32) and the Yellow-tailed Tachina fly (*E. flavicauda* Riley, Fig. 33) are known to infest it. Seizing the first opportunity to attach their eggs behind the heads of the army-worms, these flies are as persistent in their work of destruction as the worms are restless under attack. No worm carries these eggs into the ground with it but falls a victim to the maggots hatching therefrom, and which in a very short time become flies like the parent.

[Fig. 32.]

ARMY WORM TACHINA-FLY.

[Fig. 33.]



YELLOW-TAILED TACHINA-FLY.

Fully eighty per cent. of the worms which I noticed last year had been attacked by these Tachina flies, which though rendering most efficient service to the farmer, are not unfrequently supposed by him to be the parent and the cause of the worms.*

The next most common parasite of the Army-worm is the Military Microgaster (*Microgaster militaris* Walsh, Fig. 34), a little black clear-wing fly with rufous legs. The larvæ of this fly infest the worm in great numbers, and so enfeeble it that it cannot enter the ground, but lingers—sluggish and paralyzed—on some grass or grain stalk. Presently the little parasites all issue from its body and spin in concert a large amount of cottony silk, in which each individual forms a neat little egg-like cocoon. These are often mistaken by those unread in Nature's mysteries for Army Worm eggs. No greater mistake could be made. This little friend is in its turn preyed upon by a secondary parasite (*Glyphe veridascens* Walsh) belonging to the Chalcid Family.

[Fig. 34.]

MILITARY MICROGASTER.

[Fig. 35.]

GLASSY MESOCHORUS.

The Glassy Mesochorus (*Mesochorus vitreus* Walsh), is another clear-winged fly that attacks the Army Worm. It is but slightly larger than the preceding, and easily distinguished from it by the more graceful form and by a translucent yellowish-white spot in the middle of the abdomen.

* No less than four of my correspondents have expressed belief that, in the language of one of them, the worms came from "a dark colored, fuzzy fly about the size of a blow-fly, which is noticed around old stack yards just before the worm comes; and when plentiful, the Army Worm is sure to follow."

The Diminished Pezomachus (*Pezomachus minimus* Walsh) is a small wingless parasite which, like the Microgaster, spins cocoons in cottony floss on the back of the worm, but places them close together in symmetrical order. This in its turn is preyed upon by a little Chalcis-fly (*Chalcis albifrons* Walsh.)

[Fig. 36.]

PEZOMACHUS MINIMUS.

[Fig. 37.]

COCOONS OF PEZOMACHUS.

All the small clear-wing parasites, with their secondary parasites, were reared in 1861 by Mr. Walsh, and full descriptions will be found of them in the article of his which I have already cited, and in my Second Report. I reared all of them again last summer, and, in addition, a *Microgaster*, which differs from *militaris* in always having the three basal joints of the abdomen rufous, but which is, perhaps, only a variety. While about 90 per cent of the army worms are often destroyed by the primary parasites, only about 18 per cent of these are destroyed by secondary species.

In addition to these small parasites there are a few larger, Ichneumon-flies that infest the worm. One — the Purged Ophion (*Ophion purgatus* Say, Fig. 38) is a honey-yellow, slender-bodied, waspish insect, with a short ovipositor, the female of which, according to Dr. Packard, attaches her egg, which is bean-shaped, by a pedicel to the skin of the worm; and the footless grub which hatches therefrom, does not entirely leave the egg-shell, but the last joints of the body remain attached thereto, while the larva reaches over and gnaws into the side of the worm. I have bred this same species from various cut-worms, and it spins a tough, brown, silken, oblong-oval cocoon.

[Fig. 38.]

OPHION PURGATUS.

Another species, a true Ichneumon, which may be called the Army Worm Ichneumon-fly (*Ichneumon leucaniæ* Fitch), was reared from the worm by Dr. Fitch; while two other species are figured in Harris's *Injurious Insects* (3rd edition p. 630).

REMEDIES.

In the way of prevention it is a well established fact that burning over a meadow, or prairie, or field of stubble in the Winter or in Spring is an effectual guard against the origin of the worm in such meadow or field. Such burning necessarily destroys those eggs that may be laid in the Fall of the year, and the fact that it is so effectual a preventive has been relied on as evidence that the eggs must be laid in

the Fall. Having already shown that there is every reason to believe that a proportion of the eggs (the proportion increasing northward) are laid early in Spring, and that they are laid by preference—if not solely—in or on the mature or last year's stalks, it follows that burning will prove effectual in either event; for a burned field presents no such mature stalks in Spring. Heavy rolling on land that is sufficiently smooth would have a similar beneficial effect, and may also be employed to good advantage to destroy the worms after they have hatched.

As the Army Worm appears in vast numbers during certain years only, and at irregular intervals, and as this appearance is rather sudden and seldom, if ever, anticipated by the farmer, burning as a remedy loses much of its importance, except where it is practiced annually; and in view of the benefit of such burning in destroying chinch bugs and other insects it is to be regretted that the practice of winter burning of fields, prairies, straw-piles, weeds and other litter and rubbish does not more generally prevail: the destruction of injurious insects by such a system would far outweigh the benefit derived from plowing these stalks and weeds under or leaving them to gradually decay.

The worms may be prevented, as a general thing, from passing from one field to another, by judicious ditching. It is important, however, that the ditch should be made so that the side toward the field to be protected be dug under. About every three or four rods a deep hole in the ditch should be made, in which the worms will collect, so that they can be killed by covering them with earth and pressing it down. They may also be destroyed by burning straw over them—the fire not only killing the worms, but rendering the ditch friable and more efficient in preventing their ascent. I have also used coal oil to good advantage, and the worms have a great antipathy to pass a streak of it. Many of my correspondents successfully headed them off by a plowed furrow six or eight inches deep, and kept friable by dragging brush in it. Along the ditch or furrow on the side of the field to be protected, a space of from three to five feet might be thoroughly dusted (when the dew is on) with a mixture of Paris green and plaster, or flour, so that every worm which succeeds in crossing the ditch will be killed by feeding upon plants so treated. This mixture should be in the proportion of one part of pure Paris green to twenty-five or thirty parts of the other materials named. If used in a liquid form, one tablespoonful of Paris green to a bucket of water, kept well stirred, will answer the same purpose. I proved last Spring that this mixture deals death to the worms, but it should only be used

where there is no danger of its poisoning other animals. Logs or fences over running streams should be removed; otherwise the worms will cross on them.

Hogs, as already stated, are very fond of them and may often be used to good advantage; and so may chickens, geese, and other fowls.

SUMMARY.

To summarize from what has preceded, the more important points in the history of the Army Worm, and what we now know of it may be thus stated:

The Army Worm comes from a buff-colored moth having a conspicuous white speck about the middle of each of the front wings. This moth haunts our fields from the middle of June till Winter. Those which issue early in the season probably lay their eggs in Fall, while those which issue later hibernate and lay their eggs in Spring. The eggs are most probably laid on mature grass and grain stalks, whether cut and in stack, or standing. They are either inserted between the stalk and sheath, or attached in rows along the stalk. The worms, when not excessively numerous, hide during the day and are seldom noticed. In years of great abundance they are also generally unnoticed during their early life. The earliest acquire full growth and commence to travel in armies and to devastate our fields and attract attention, about the time that winter wheat is in the milk. They soon afterwards descend into the ground and thus suddenly disappear, to issue again two or three weeks later as moths. The bulk of the worms become moths in this latitude the same season; but a few probably hibernate in the pupa state below ground, and the proportion of these increases as we go north. There is but one generation annually. The worms abound during wet Springs, preceded by one or more very dry years. They are preyed upon by numerous enemies which so effectually check their increase during years of great multiplication, that two great Army Worm years have never followed each other and are not likely to do so. They may be prevented from invading a field by judicious ditching, and burning over a field in Winter or early Spring, effectually prevents their hatching in such field.

THE ROCKY MOUNTAIN LOCUST—*Caloptenus spretus* Thomas.

(Ord. ORTHOPTERA; Fam. ACRIDIDÆ.)

Serious and distressing as were the ravages of this insect in 1874, when the winged swarms overswept several of the Western States, and poured into our western counties in the Fall, the injury and suffering that ensued were as naught, in Missouri, compared to what resulted from the unfledged myriads that hatched out in the Spring of 1875. As nothing in the way of insect ravages had before equaled it in the history of the State, and as the history of this calamity, so fraught with valuable experience and instruction, will form an important record for future reference, if condensed and brought together in an accessible work, I shall devote a large part of the present Report to this insect plague—supplementing the article published in the Report for 1874, by the experience and observation of 1875. It was almost universally admitted by our farmers that, grave as was the affliction, they could have overcome it without great difficulty, if they had had, at the beginning, the experience they had gained by the end of the visitation; and it is my hope that in the event of another such occurrence, the experience here recorded may be made available.

PREVIOUS EXPERIENCE IN THE SPRING OF 1867.

During my travels in the middle western counties of Pettis, Johnson, Lafayette, Jackson and Cass, in which the injury was perhaps the greatest, few things struck me as more remarkable than the little that was remembered by the inhabitants of the previous visitation in the Spring of 1867. Occasionally I would meet with a man who recollected quite distinctly the doings of the young locusts in that year, and such an one profited to great advantage by that experience; but what with new comers since 1867, and want of records, the large proportion whom I met with knew little about it. Another important reason why the farmers were ill prepared for the desolation of last Spring is found in the fact that the previous injury of 1867, from one cause and another, was by no means as wide spread and severe—the insects did not so generally hatch in such immense numbers; they were more generally attacked by enemies, especially black birds, and the people were in much better material condition to withstand them, and sustain the temporary injury. It will be interesting here to reproduce what was published in my last Report as to the injury that might be expected in the Spring of 1875. The predications were based not only on the general habits and ways of the young insects, but on the experience of 1867, as far as it could be learned:

Setting aside possible but not probable injury from a new invasion, we may consider the probable injury that will result in 1875, from the progeny of those which came in 1874. The eggs which are deposited on southerly hill-sides often hatch before cold weather sets in, if the Fall be warm and protracted, while many hatch soon after the frost is out of the ground in the Spring. Yet the great bulk of them will not hatch till into April. That most of the eggs will hatch may be taken for granted unless we have very abnormal climatic conditions, and unprecedentedly wet and cold weather following a mild and thawing spell. The young issuing from these eggs will, also, in all probability, do much damage, as they did in the Spring and Summer of 1867. But the actual damage cannot be foretold, as so much depends on circumstances. In 1867, in many counties of Kansas and Missouri, where the ground had been filled with eggs the previous Fall, little harm was done in the Spring—so small a percentage of the eggs came to anything and so unmercifully were the young destroyed by natural enemies. A severe frost kills the young after they have hatched, where a moderate frost does not affect them. In Missouri, if we have no weather that prove fatal to either eggs or young, considerable damage may be expected, but not as much as in the country to the West; for, as already stated, we received the more scattering remains of the vast army, and the eggs are neither as numerous, nor will they hatch as early in our territory as farther West. Following a rather mild February the March of '67 was a very severe one, the thermometer frequently indicating 18 degrees below zero, and, according to Mr. W. F. Goble, of Pleasant Ridge, Kansas, who wrote an excellent account of the insect,* this severe weather caused many of the eggs to perish; and he expresses the opinion that "judging from the voraciousness of those that did appear, I doubt not Kansas would have been made a perfect desert if all had lived."

If after the young hoppers hatch we have much cold wet weather, great numbers of them will congregate in sheltered places and perish before doing serious harm; but if, on the contrary, our Spring and early Summer prove dry and hot (which is hardly to be expected after the several dry seasons lately experienced) much damage will result from these young locusts, where no effort is made to prevent it. They will ruin most garden truck, do much injury to grain, and affect plants very much in the order previously indicated under the head of "Food-plants." They will become more and more injurious as they get older, until, in about two months from the time of hatching, or about the middle of June, they will begin to acquire wings, become restless, and in all probability leave the locality where they were born, either wending their way further South or returning in the direction whence their parents came the previous year. Some bevies may even pass to the eastward of the limit line reached in 1874, and fall upon some of the counties bordering that line; but they will lay no eggs, and will, in time, run their course and perish from debility, disease and parasites. In 1876 the Rocky Mountain Locust will scarcely be heard of within our borders; a few remnants from Kansas or Nebraska, or from the country to the southwest, may make their presence manifest, if the year should be exceptionally favorable to their development; but, whether delayed till 1876, or even till 1877, the last one will eventually vanish from Missouri soil, and their race will no more be known among us till—perhaps within the next six or eight years; perhaps not within the next twenty—a fresh swarm wings its way to our borders from the plains along the mountain regions. There is, therefore, no danger of their overrunning the State to the east of the limit line; nor of their doing permanent injury in the counties they now occupy.—[7th Report, pp. 166–7.

How closely subsequent events verified these predications, the following pages and the experience of 1875, so fresh in the minds of our people, attest. Yet the fearful devastation that actually followed was scarcely anticipated, and the conclusion there drawn that the eggs in our western counties invaded were less numerous than in the country further west proved incorrect, for the insects were fully as numerous within our borders as they were across the line in the eastern part of Kansas.

The territory which received the last remnants of the vast army, and in which, from the more scattered numbers and greater debility of the insects, fewer eggs were laid, was less extensive than I had calculated, and as will be seen from the chapters where I more particularly

*Monthly Reports, Dep. Agr. 1867, p. 299.

treat of Missouri, was confined to those counties along the extreme eastern limit of the 1874 invasion, and more particularly to the southwest counties.

I think that the greater numbers in 1875 as compared to 1867 were more owing to the characters of the two seasons than to any disproportion in the number of the eggs laid. The Winter of 1874–5, though commencing late, was severe, steady and protracted till toward the first of May, when Spring suddenly came upon us in full force. There was no very variable weather in the earlier months; whereas such weather did occur in 1867, and the insects not only hatched earlier and were exposed to enemies and adverse influences for a longer time before they could begin to thrive, but they were also more seriously affected by the sudden changes—a steady Winter, however severe, being more favorable to almost all insects than an open and changeable one.

Although the insects came nearly a month later in 1866 than in 1874, and left two or three weeks later in 1867 than in 1875, yet good crops were subsequently grown in 1867; and to show how history repeats itself, I reproduce here extracts from the Kansas City *Journal of Commerce*, for June and July, 1867. The exodus was made during the last week of June, and, as last year, in a N.W. direction.

June 6. "These 'winged beasts' are growing and multiplying amazingly, and their appetite is inordinate."

June 7. "A farmer near Platte river informs us that a morning or two ago he went out to plow his corn, which was about four inches high the day before, and found it all gone."

June 9. "Grasshoppers alarmingly thick at Westport."

June 13. "There seems to be a difference of opinion among farmers. Some say the grasshoppers are destroying everything, and others declare they have touched none of the growing crops."

June 19. "Grasshoppers have opened out on the onion crop in Atchison county, Kansas."

June 22. "The Lawrence *Journal* mentions that a number of gentlemen had carefully watched one swarm of grasshoppers, and they moved south more than two miles in one week. They stopped no longer in grain fields than on bare ground."

Also. "Leavenworth papers report millions of grasshoppers. They have eaten all the smartweed out of Delaware street, and have now commenced on the dog-fennel in some of the main thoroughfares of that prosperous town."

June 25. A reporter visited the place of Major Hudson, on the Shawnee road, the same now owned and occupied by Dr. Thorne, and says: "Grasshoppers are now paying him a visit, and it is taking nearly all he can raise to entertain them. They are making a heavy raid on the gardens and grainfields in this locality."

June 26. "The grasshoppers in this neighborhood do not confine themselves to hopping, but now wing it, and are more animated than ever. Their appetites grow with their stomachs, and their ravages keep pace with both. They appear to be departing, shaping their course eastwardly."

June 28. "We understand that around Westport and Independence the grasshoppers are still doing a great deal of damage. In this locality they are thinning out a little."

June 29. "The grasshoppers are migrating to the northwest by the million. They fly at a great height and are as thick as snow-flakes. It is a goodly sight to see their departure."

Also. "In St. Joseph the grasshoppers are reported as the sands of the sea, and sweeping everything before them."

July 2. "Grasshoppers continue to spread themselves considerably in this locality, but they are not so thick as they were and are evidently migrating."

July 10. "Grasshoppers are all gone from Fort Scott. * * The Kansas City markets are abundantly supplied with garden truck, and cheap."

GENERAL OUTLOOK IN THE SPRING OF 1875.

The Spring of 1875 brought the farmers of the locust region to a crisis somewhat unusual and peculiar. Two previous years of drouth and chinch bugs, followed by the locust incursion of the previous Fall, had armed the people with unusual energy, born of hope and necessity, and there was everywhere determination to put forth the very best efforts. The opening of the Spring favored the execution of this purpose. Timely rains and bright weather crowned the seeding time with unusual hope, and a much larger acreage of all Spring crops was planted. The experience of previous locust years had been generally forgotton, and no effort to destroy the eggs had been made. The same genial sun that made wheat, oats, corn and flax grow apace, brought into activity myriads of the dreaded destroyers. Scarcely had the farmer begun to rejoice over a prospect of uncommon promise, when he saw his fields invaded by an enemy that overcame his utmost resistance. The severely stricken region, covering an area variously estimated at from 200 to 270 miles from East to West, and from 250 to 350 miles from North to South, and embracing portions of Nebraska, Kansas and Missouri, presented a variety of experience, some portions being comparatively exempt from injury, while others wore an aspect of devastation that changed the verdure of Spring into the barrenness of Winter.

The tract in which the injury done by the destructive enemy was worst, was confined to the two western tiers of Counties in Missouri, and the four tiers of Counties in Kansas, bounded by the Missouri river on the East. The greatest damage extended over a strip 25 miles each side of the Missouri river, from Omaha to Kansas City, and then extending South to the Southwestern limit of Missouri. About three quarters of a million of people were to a greater or less extent made sufferers. The experience of different localities was not equal or uniform. Contiguous farms sometimes presented the contrast of abundance and utter want, according to the caprices of the invaders or according as they hatched in localities favorable to the laying of the eggs. This fact gave rise to contradictory reports, each particular locality generalizing from its own experience. The fact is, however, that over the region described there was a very general devastation, involving the destruction of three fourths of all field and garden crops.

For the relief of the sufferers there came the frequent and growing rains, carrying Spring far into the usually droughty Summer, and

giving the subsequent planting an admirable start. Then when the pests had increased to their highest number, and were working the most extensive ruin, the flood gates of the clouds were opened, and for thirty-six hours an unceasing torrent swept large numbers of the pests into the streams until the surface of most running water was black with locusts. For the destitution of Kansas an extra session of the Legislature provided partial relief. In both Kansas and Missouri, wherever the scourge extended, seeds were to some extent distributed by the Department of Agriculture, and by enterprising seedsmen, and committees were sent to more favored regions to obtain contributions of money, provisions and seed. In order to convey a more exact idea of the condition of things that prevailed, and of the injuries of the insect, outside of the more severely visited region, I will give a review by States, and in the case of Missouri by counties also.

THE OUTLOOK IN MISSOURI.

Early in May the reports from the locust district of the State were very conflicting: the insects were confined to within short radii of their hatching grounds. The season was propitious, and where the insects did not occur, everything promised well. As the month drew more and more to a close, the insects extended the area of destruction and the alarm became general. By the end of the month the non-timbered portions of the middle western counties were as bare as in winter. Here and there patches of *Amarantus Blitum* and a few jagged stalks of Milkweed (*Asclepias*) served to relieve the monotony. An occasional oat field, or low piece of prairie would also remain green; but with these exceptions one might travel for days by buggy and find everything eaten off, even to the under-brush in the woods. The suffering was great and the people were well-nigh disheartened. Cattle and stock of all kinds, except hogs and poultry, were driven away to more favored counties, and relief committees were organized. Many families left the State under the influence of the temporary panic and the unnecessary forbodings and exaggerated statements of pessimists. Chronic loafers and idlers even made some trouble and threatened to seize the goods and property of the well to do. Relief work was, however, carried on energetically, and with few exceptions no violence occurred. Early in June the insects began to leave; the farmers began replanting with a will. As the month advanced, the prospects brightened, and by the Fourth of July the whole country presented a green and thrifty appearance again. The greatest damage occurred in the counties bordering the Missouri river to Liberty, and thence southward; and Bates, Buchanan, Barton, Clay, Cass, Clinton, Henry, Jackson, Johnson, Lafayette, Platte, St. Clair and Ver-

non suffered most. The other counties in the district invaded in 1874, and especially those along the eastern border of that district, as indicated in my map of last year, suffered less. In some of these, as in the extreme northwest counties, the reason may be found in the fact that the winged insects of 1874 did not stay long enough to lay excessive numbers of eggs; while in those along the eastern border, the reason is to be found in the fact that, as I stated last year, the winged swarms, when they reached this limit, were weakened and decimated: they were the straggling remains of the vast army. But in order to more correctly state the condition, it will be best to particularize by counties, in doing which, I shall endeavor to record the facts as far as possible in the words of residents themselves.

Atchison County.—The extreme northwest corner of the State, bordered on the west by the Missouri river, with rich rolling prairie, interspersed with timber along the streams, and extensive bottom land—this county suffered severely. Mr. R. Bottom, of Rockport, made the following report about the middle of May:

The locusts are taking every green thing as fast as it appears above the ground in this part of the county, say ten or twelve miles from the river. Beyond that I am told there is little small grain, vegetables and corn. Most of the county shows as little sign of vegetation as it did in March, except the trees. All small fruit is gone, they have even eaten the weeds. We are rebreaking our land to sow millet and Hungarian grass and plant corn for fodder, after they leave. If we can't raise something in this way this section will be destitute of anything to eat for man or beast. The question is, what shall we do? But few men have money enough to buy corn to do them until they raise another crop. I fully believe if we had commenced in time we could have saved our crops by killing them. I tried my best to convince the farmers in my neighborhood but could only get a few into it. I am sure I have killed more than was hatched on my farm. My plan is to dig deep ditches along the fence in their run with a deep hole at each end of the ditch, into which they pile up and kill each other or smother to death. Holes bored with a post augur is a very good plan. In order to collect them in the ditch I took forty yards of domestic, cut in the middle, made two wings like a partridge net, tacking to stakes every ten feet. Start at one end and stake down at each corner of the ditch slanting inwards, fit down well to the ground so they can't crawl under, this conducts them to the ditch; get ahead of them when they start to travel. I have tried many plans but this is the best. Coal oil will kill them; a shallow ditch will do with water in it, and a pint of coal oil poured in when the ground will hold water.

No general measures of relief were adopted, so far as I have been able to learn.

Andrew County.—This county, though in the heart of the infested region, suffered comparatively little. Mr. J. H. Smith, of Whitesville, places the damage at 50 per cent. of all crops, and Mr. Jno. White, of Flag Springs, writes me that of the first planting not one acre in a hundred was left in most sections. "All the oats, Spring wheat and most of Fall wheat, potatoes, vegetable of all kinds, were eaten down; but with nerve the people went to work and had plenty in the Fall, though a million dollars would not make up the injury."

Benton County.—The damage in a few localities was great, but Mr. J. H. Lay, of Warsaw, writes that taking the county as a whole it was very slight.

Barton County.—The general destruction and consequent distress were not so great here as in counties further north. Winter wheat and rye turned out well, but of oats and Spring wheat fully one-fourth of the crop was destroyed by the locusts.

W. B. Krimminger, of Leroy, wrote, May 21:

Grasshoppers have been hatching here for about seven weeks in this locality (township 33, range 32 west) but have not done much damage except to cut out some gardens.

The only effect Fall plowing had on grasshopper eggs was to cause them to hatch out later; perhaps the result would have been different if our winter had been wet instead of extremely dry.

The insects were leaving in a north and north-west direction every favorable day throughout most of June, and by the end of that month farmers were jubilant over the brightened prospects.

Bates County.—Lying near the centre of the region where the eggs were most thickly laid, this county suffered severely. The people were in a condition that outside help was imperative to save many families from actual starvation. For miles and miles every green thing that grew out of or upon the ground had been literally devoured. Committees were sent to Kansas City and St. Louis asking for help, and brought back cheering words and timely aid to the hungry and despairing at home.

Jno. B. Durand, of Prairie City, wrote me, May 17:

The locusts are of more notoriety here at present than anything else. It is actually alarming and distressing to see all our crops and pastures eaten off until they are as bare as in midwinter. They take everything green, even tobacco. They keep the leaves off of some of my apple trees so that I am afraid they will die.

A prominent merchant of Butler, wrote, May 19, to the *St. Louis Globe-Democrat:*

We are having terrible times in this county now. The grasshoppers have destroyed the country; there is scarcely a green shrub in the country. All of our crops are destroyed, and there is no prospect of the hoppers leaving. Our town is being threatened with a raid by the starving people from the country.

Our condition is awful, and God only knows where it will all end.

The merchants and citizens of that town and vicinity held several meetings, and raised enough money to purchase a car load of seed corn. This was distributed to responsible farmers *for seed only.* Other arrangements were made to supply the immediate wants of the people and Messrs. Devinney, Hannah and Childs were appointed a committee to distribute the corn.

By the end of May the condition began to change for the better, and by the middle of July everything looked promising. There was just rain enough to make the corn grow rapidly. But little wheat had been sown; oats produced a fair crop; flax yielded about one-quarter of a crop. A large amount of castor beans was planted, and the crop was excellent.

BUCHANAN COUNTY.—By the end of May the reports from this county were various and the opinions of farmers differed widely. The insects were in spots. Some farms had not been touched at all, while others had been stripped of every green thing. They impeded the progress of the trains on the railroads, and in some places created a most disagreeable stench. In most parts of the county so completely did the locusts do their work, that, had it not been for the foliage borne by the loftier timber, the general aspect of nearly all parts of the county would have been that of Winter.

The following letter, written June 7, by J. S. Talbot, of Easton, to the Hon. Waller Young, and read before the State Board of Equalization, then in session, conveys, perhaps, the most correct idea of affairs:

> In answer to your inquiry, I would say that our prospects are gloomy indeed. I think by the time the hoppers leave here they will have devoured everything green. The crops are about all destroyed now, together with meadows and pastures. The country would present the appearance of winter if it were not for the foliage of the timber. The leaves are all stripped off the hazel bushes. I think they will live on us yet some three weeks. If they stay this length of time God only knows what will be the result with this people. The farmers are generally in good spirits. Some are planting, others are going to commence in eight or ten days, hoping the 'hoppers will leave by the time the corn comes up. The outlook is a dark one. There are but few who have the seed, fewer who have anything to support teams necessary to raise crops. Do all you can to reduce the burdens of the tax-paying farmers. Many of them have not paid last year's taxes, and what is to be done in the premises I am unable to say. It seems to me there ought to be a called session of the Legislature and some relief afforded in the shape of stay-laws as to taxes and debts. So far the people seem very indulgent as to debtors. There is but little money here. My crops are all gone—fifty acres of corn, the same amount of wheat, twenty acres of oats and fifty acres of meadow. The most of the meadows are killed outright. Much of the stock is being taken north into Gentry, DeKalb and other counties. It would astonish you to see the courage of the farmers, the surroundings considered. They are determined to keep up courage and hope for success; will not beg or ask for outside assistance till the last vestige of hope is gone. If the hoppers will leave in two weeks we can raise plenty to winter on.

The request there made to reduce the taxable valuation of the property of the county was granted, and no further measures for general relief were adopted.

CALDWELL COUNTY.—The injury was confined to the extreme southwest corner of the county. Reports from C. L. Gould, of Hamilton, and D. W. Monroe, of Kidder, show that even here the damage was slight.

CASS COUNTY.—Sustained perhaps the most damage of any of the counties in the afflicted district. The general expression that it was

the darkest day ever experienced by the people of the county, does not overstate the true condition of things. From many graphic accounts of the outlook in this county, I select the two following, as according most nearly with my own experience.

In April the locusts commenced hatching out in countless millions, and every day since that time large swarms have come to the surface. As soon as they were able to hop and eat, which seems to be in about thirty minutes after incubation, they commenced their depredations. Since that time, though millions have been destroyed, their capacity for destruction has increased. In spots they cover the ground completely; sometimes bushels of them can be scooped up from the area of a few square feet. These will invade a wheat, oats or flax field, and in a few hours scarcely a vestige of vegetation is to be seen. They climb currant and gooseberry bushes, and in a short time the bushes will be entirely stripped of fruit and foliage. They have invaded almost every garden, meadow, wheat, oats, flax and rye field in the county, and have devoured them. * * * * * * * * *

It would be impossible to give in our brief article an adequate idea of their devastation in Cass county. Mr. Lee Emerick says they took fifteen acres of fine oats for him in three hours. Judge Frank Clark had a fine field of wheat which was entirely destroyed last Sunday afternoon. Numberless instances could be given of fields perfectly beautiful in verdure one morning, presenting an aspect as bare of vegetation by the next day as they were at planting time.—[*Cass County Courier*, May 21, 1875.

Those persons at a distance and out of range of the plague can have but a faint idea of our situation, nor can they comprehend the fearful ravages made by these pests. These have already eaten up the wheat and oats, and are taking the corn that is planted as fast as it appears above the ground. Our gardens and meadows have been totally despoiled, and our once beautiful, flower-decked prairies now look as desolate and barren as the desert. Our stock will either have to be sent off or starve, as there is nothing for them to eat. The influence of the plague (there is no use denying the fact) is being severely felt in our towns and cities by all classes. Business is becoming stagnated, work of all kinds is on the decline, and gloom and despondency fill almost every heart at the prospect of famine and possible starvation, which must surely come unless assistance comes from some source.—[*Pleasant Hill Review*, May 25, 1875.

Mr. W. H. Barrett, a prominent merchant of Harrisonville, wrote me, May 27:

In reply to your enquiries about destruction of crops, I will say, of my own personal knowledge, as follows: I had loaned flax seed enough to sow an acreage of ten thousand acres, and now there is not one acre left standing in the county. I have some five thousand acres of castor beans out and I find that they are not damaged to any great extent, and this is the only exception of any crop I know of in the county. Flax, oats, wheat, early corn, and in fact every green vegetable is destroyed, and they are now working on the fruit of all kinds, and I find all of this year's growth of young trees is being eaten off and great apprehension is felt for fear they will kill the trees. In fact, all the small fruits are eaten bare, and in my opinion, are now killed.

Even the forest trees did not escape the destroyer. The castor bean, which the locusts at first refused, was finally to some extent eaten. Large fields were swept away with marvelous rapidity. One farmer testifies that he had one hundred and sixty acres of wheat, rye, oats and corn in fine condition, and that thirty-six hours after his fields were attacked, not a hat full of grain was left.

The almost entire loss of crops of the year previous by drouth and chinch bug, left the people in a sad condition to encounter the misfortunes of 1875. More or less distress settled upon all classes of peo-

ple, and meetings were held in the different townships of the county for the purpose of ascertaining the extent of the damage done, and to devise measures of relief from the scarcity of food for man and beast, and from the want of seed for a new planting. A county convention was held at Harrisonville, May 18, 1875, to receive reports from the various townships in regard to the destruction of crops by the insects. A large number of the citizens of the county were present. Col. H. M. Bledsoe was called to the chair and J. F. Potts was appointed secretary. A call of the townships disclosed the fact that a large number of persons were destitute, and that immediate action must be taken to escape actual starvation. It was found that the County Court was powerless to extend aid on account of the express limitation of the statute. A resolution was passed requesting the Governor to call a special session of the Legislature to take into consideration the state of things and administer relief.

It was also resolved to hold township meetings on the 22d of May, and another county convention in Harrisonville on the 24th of the same month. This subsequent convention was held, reports received from the townships, and the county court requested to appoint a committee of four to proceed to St. Louis and solicit aid.

I twice visited this county and was kindly received by Dr. T. Beattie, Judge H. Glenn, W. H. Barrett, Dr. Abraham, G. M. Houston, Wm. H. Allen, and the Editor of the *Courier*. Visiting the adjacent woods and fields I found that the accounts of the destruction had not been overstated. Being called upon to address the citizens at the court house at Harrisonville, I set forth the history, origin and habits of this locust, stating when the insects would leave, the direction they would most likely take, and endeavored to encourage the people by the assurance that the distress then afflicting them was but temporary and would be followed by abundance.*

As part of the history of the locust troubles in Cass county, and in illustration of the change that three months wrought, I take the liberty of reproducing the following from a report made by the Kansas City *Times* of an address I was called upon to deliver in the same hall, the latter part of September, and in which I endeavored to bring together the dear bought lessons of the year:

Gentlemen—Farmers of Cass County: I left you, hardly more than three months since, with long faces, discouraged, forlorn. You were in despair and almost heart-broken over the gloomy prospects. Desolation and distress surrounded you on every

*With what result, the following extract from a letter from Mr. Geo. M. Houston of that place, will indicate : "Your talk here to our farmers and citizens has had an excellent effect. Every person appears to be in a more hopeful mood. Farmers are talking about following out your advice in planting corn, etc., immediately."

hand, and there was enough to make you discouraged. I told you that the people of the State were, as a whole, blessed with a plenty, and prosperous, and that they would not see you suffer. The noble generosity of our more fortunate citizens to the east, and especially of the people of St. Louis, in relieving your more pressing wants at the time, have since justified my good opinion of our people. At the same time I gave you a full account of the habits and ways of the locust plague, and endeavored to imbue you with confidence and hope by showing that your then distress was temporary, that the plague would leave you at a certain time, and that you would yet be blessed with abundant harvests. I told you that I was imperatively called away to Europe, and should be absent from the country during most of the summer, but that, though I left you in distress, I expected to come back and find you growing the largest crops of most kinds. Surrounded with such gloomy prospects, it was difficult for you to take such a bright view of the future, and while many of you were encouraged and had full faith in my predictions, some of you no doubt went away as doubters. Nor could I wonder at the doubters, because, in spite of the fact that an account of the insect was given in my last official report, and that I had given substantial reasons why the pest would not extend farther east, and would not remain with you, some of our influential journals were not only filled with ridiculous ideas as to the insect's natural history, written by correspondents unfamiliar with the first principles of entomology, but they persisted in spreading the idea that the western counties were to permanently suffer from the scourge, and that it was going to overrun the State and other States to the east—thus unnecessarily increasing the panic, injuring the credit of these counties, and causing many to leave who would otherwise have stayed.

I come back among you to find all my predictions verified, and I joy with you in the bounteous corn crop which I see on all hands, the rich vegetable harvest, and the excellent condition of your pastures and stock. From the first I have placed myself on record, and to do so, it required that faith and confidence born of full consciousness of the fact that my opinions were based on scientific data. It is no slight matter for a public officer to thus risk his reputation, and were you now suffering as you did last Spring, or had my predictions not been so fully verified, your State Entomologist would no doubt be condemned in words by no means measured.

Clay County.—Here again the insects were very bad and trains on the Cameron Branch of the Hannibal and St. Joseph Railroad were often reported as stopped by them. The injury was, however, not general. Many parts of the county were bared, but in the larger portion the wheat and corn were not seriously affected, and by the end of June the insects were flying north in multitudes. Corn was being everywhere replanted and the ground extensively prepared for hungarian and millet. The following correspondence of the St. Joseph *Weekly Herald* shows the condition of things about the end of May:

Liberty, May 28, 1875.—The grasshoppers in Clay county are doing great damage to the garden and present growing crops. In Liberty, the citizens fought bravely in hopes of keeping them out of their gardens. This week they surrendered. Mr. Hopper has the field. In the county they have ruined several crops, but some still not damaged. Everything green seems to be their preferred dish.

The feed for work stock is entirely exhausted, and the last hope the farmers had to put in their second crop was for their stock to subsist on grass, which last hope is disappearing fast. Several are driving their stock north to graze. Report says our neighbors are objecting, saying they must have what grass is left for themselves.

The hoppers are also doing great damage to the fruit in many places. But our farmers have the Jackson kind of nerve and are determined to pick their flint and try it again.

Kearney, May 28, 1875.—The prospect at present is rather gloomy. The gardens are nearly all destroyed. Oats, clover, and in fact all small grain have suffered considerably from the ravages of the grasshopper, and from a number of farmers we hear that their corn is going too. The recent heavy rains have livened up everything wonderfully, and there is still a prospect for an abundant corn crop, if the pests do not injure it any more than they have done. The citizens of this (Kearney) township will hold a mass meeting next Tuesday, the 1st, to consider the best means of meeting the coming emergency and to mutually aid and assist each other.

CLINTON COUNTY.—Accounts gathered from this county are somewhat meagre. The St. Joseph *Weekly Herald*, May 21, contains the following item from Cameron:

There are still no indications of the grasshopper plague in this vicinity, though they have done some damage in and about Perrin, some eight miles southwest of here, on the line of the railroad. So far none have been discovered north, east or south of us, only west and southwest. At Plattsburg, twenty miles southwest, they are to be found in countless millions, and have done great injury to wheat and corn. The farmers in the devastated sections are replanting corn, and the prevailing sentiment seems to be more hopeful than at last report.

At a later date, June 14, Capt. M. S. Payne writes:

As regards the ravages of the locusts, they are fearful, although the air is filled with vast swarms of them like so many bees that had escaped from a hive on their way to other lands, yet enough remains to destroy all vegetation as fast as it comes on, and all prospects for a crop, and sustenance for the coming Winter, unless they leave in the next ten days. The two previous years of drouth in northwest Missouri, together with the enormous financial pressure and heavy taxation have left the people without resource against the fearful invasions of these devouring insects.

They came out of a hard, cold Winter, with stock poor and weak. Many good industrious citizens reached the very bottom of their corn cribs long before Spring opened, and the weather was so cold and dry, and vegetation was so exceedingly backward that the locusts got the advantage and have kept it.

All the meadows, both clover and timothy, are absolutely destroyed, and nothing but frequent and heavy rains will save the blue grass. Our meadow of forty acres is as bare and as desolate as if it had been swept by a fire; both pastures are (with the exception of the green trees) as bleak as Winter. There is no grass left on the place but the little slope of blue grass that runs back of the barn, and that is kept very short. Our corn is still standing, although much injured, and we do not know how soon it will be taken, the oats next to it were black with them yesterday.

* * * * * *

The devastation is much heavier and more universal on the west and south sides of the county. The hazel and undergrowth are as leafless as in Winter—all the small fruits of every description are destroyed. Those who were depending on their gardens for support are left destitute, and in the northern and eastern portions of the county, where there is any prairie unenclosed, the grass is not much injured, but there are such vast quantities of stock on it that it affords a meagre sustenance.

Those who expected to plow, off the grass, are left without sustenance for their teams while making a crop, even if the hoppers leave in time for them to replant, and they can succeed in procuring the necessary seeds. Many farmers will have to plow with very poor horses through the hottest and most exhausting weather without feed.

* * * * * *

Our people are brave and persevering and the majority of them will do all that human labor and human skill can accomplish, if they can get the right kind of seeds. Not corn alone is needed, but potatoes, navy beans, Michigan peas, buckwheat, millet, Hungarian, turnip seed, and all kinds of late garden seeds. Tomato, sweet potato and cabbage plants could be shipped in, and if we have a late Fall they can be raised for Winter use.

DADE COUNTY.—The Dade County *Advocate* of June 3, says: "Farmers report no grasshoppers to amount to anything, and in what few places they have made their appearance they have done no damage as yet. Chinch bugs appear to be leaving most neighborhoods, and not much more damage is anticipated from them. Oats are looking well in most parts of the county."

Mr. R. A. Workman, of Greenfield, writes me: "Those that hatched out in the Spring of '75 were so few and so scattered that they did no harm, and, in fact, were scarcely noticed, and disappeared so quietly that no one knows how or where."

DEKALB COUNTY.—I clip the following from the St. Joseph *Herald* of June 3, from correspondence from Sherman township, May 31:

As assertions prove nothing I will give you the names of some responsible gentlemen who have been injured by the hopper. Capt. S. H. Varner has been run over by them for a week. They have eaten his oats and one hundred and twenty acres of meadow. As yet they have not troubled his corn, but may before night. Mr George Lowe, near Union Star, went to St. Joseph last week and bought him a new cultivator to plow his corn. He returned next day and had not a hill of corn to plow. Adam House went to St. Joseph last Tuesday and returned on Wednesday and found his corn field as bare as the day he planted it. It was six inches or more high. Of course he will plant it over again, but what surety has he that the young hoppers that are now hatching (and they are numerous) will not eat it? Judge Williams, Frank Bowen and numbers of other farmers have been injured by them, while some farms are as yet untouched.

GENTRY COUNTY.—As a whole this county was favored, though in many localities the ground was made as bare as in Winter. Mr. Levi Long, of Island City, writes:

They ate all the wheat that was on high land, also oats and corn; all garden vegetables and a great portion of the fruit. Imagine everything green on the face of the earth eat entirely up, the meadows and blue grass pastures as dry and bare of vegetation as the centre of a State road that is traveled a great deal, and you can probably form some idea of our condition at the time.

HICKORY COUNTY.—The same may be said of this as of the preceding county.

HOLT COUNTY.—In 1867 this county suffered more severely than many others, and I have several correspondents who retain a very vivid recollection of that experience. Last year the county suffered less than many others, and the pests were quite successfully fought. Many crops were saved by ditching, and in one instance a Mr. Walker is reported as saving his crops by ditching around a whole quarter section, on a place called Hackberry Ridge.[—*St. Louis Republican*, July 5.

Since our last these insects have developed their endurance beyond question. They have established a reputation for perfect indifference to storms and cold weather that is truly astounding. They are now going for garden stuff with an avidity that is rather discouraging to the planter. They went for our cabbage patch, and devoured in a few hours, what we had been several months in developing; others have been more unlucky, losing everything, cabbage, peas, raddishes, lettuce, all swept away in a few hours. Some of the farmers in this vicinity have had their wheat, oats, barley, timothy and other crops greatly injured by these pests.

Out on Hickory Creek the hoppers are not so numerous as here, and as a consequence are not doing so much injury; near Craig, Judge Van Wormer reports they are destroying the wheat. Near Forbes they are more numerous than here, and have destroyed about all the gardens; only one piece of wheat is reported as injured yet. Some other parts of the county report none, while others have enough to supply several counties.

All accounts show, however, that we are not as bad off as some of our neighbors.—[*Holt County Sentinel*, May 15.

HENRY COUNTY.—A correspondent of the *St. Louis Republican*, under date May 26, thus describes the devastation in Henry County:

The locusts have already destroyed a large portion of the crops in sections of this county, and still continue their work of devastation. The western and northern part

of this county is almost a desert, there being scarcely a vestige of *anything* green remaining to be seen. They don't seem to have any definite direction to travel, but at present they are moving southeast, and, if they continue in that course, the entire crop of this county will be destroyed. The largest are as yet not more than half grown, and will probably not be able to fly for one month or longer, while many are yet hatching. [Subsequent events proved this incorrect: the bulk of them left by the middle of June.] Our farmers are so alarmed that some are leaving their farms, while many would do so but are unable. Grass on the prairies is destroyed in certain localities and people are compelled to drive their stock some distance for grazing. Many farmers have planted their corn the second time, and will plant again if the locusts leave soon, while many have exhausted their means and will be unable to buy seed or provisions, and will actually starve unless they receive immediate relief. These are serious facts, and are entirely free from exaggeration.

A mass meeting of the citizens of the county convened at the court house on May 21st, to devise some plan of relief for the destitute. Dr. J. H. Britts was called to the chair, and Thos. Day elected secretary. A committee consisting of Messrs. McLane, Tewell, Woods, Gantt, and Dr. Salmon was appointed to prepare a plan of action. This committee reported as follows:

Your committee have come to the conclusion that we have not the means in our midst to relieve the necessities of our poor. The great destitution is alarming. We must have aid. We are now in the midst of a famine. The people of Henry county have always contributed liberally when other sections needed our aid; believing then that an appeal to those portions of our country that have been blessed will bring contributions of corn and bacon for our poor, we are in favor of sending duly accredited agents to solicit aid from the people of other portions of the country, and especially the great centers of commerce.

Committees were appointed to visit Illinois and Iowa to solicit aid. They carried the seal of the county court, and were instructed to receive and distribute contributions. The following resolutions, adopted by the meeting, express the intense feeling that pervaded the county:

Whereas, Owing to the fact that there is now great and wide-spread alarm among all classes of citizens of this county at the ravages of the grasshoppers and chinch bugs, and that much harm will necessarily inure to the growing crops of the county, and in many instances the flax crop is already destroyed; Therefore be it

Resolved, 1st, That to prevent the destitution that must necessarily follow if the crops of the county are destroyed, and not replenished, we earnestly recommend that farmers do not cease to plant as long as a crop is likely to mature at all; that after it is too late to plant corn, we recommend that hungarian and millet be sown for the purpose of supplying the deficiency of the hay crop.

2d, That it is only by earnest and persistent effort that we will be able to supply the loss caused by these pests, and to some extent prevent the calamity that now threatens us.

Resolved, That the chair appoint a committee of three to proceed to Jefferson City, and in behalf of the tax-payers of Henry County memorialize the State Board of Equalization now in session, to put the valuation of property in Henry county at its present cash value.

Jackson County.—The devastation in other adjacent counties was repeated in this. Mr. Z. F. Ragan, of Independence, with whom I spent some time during the most critical period, writes:

While young they did but little damage, neither did they excite much alarm, since persons who had resided here, when they were here in 1867, assured us that but little damage might be apprehended, inasmuch as in '67 they only cleaned up the dog-fennel along the public highways and the weeds out of the corn fields. But lo, and be-

hold! When they commenced moving in vast armies, and all kinds of growing crops disappeared before the black dead line of their advance, threatening destitution and even starvation, a general alarm pervaded the whole community, and many that had treated the matter lightly, began to comprehend the situation and saw at once, that notwithstanding they might be themselves self-sustaining, if they were surrounded by destitute and needy people, they could have no security in what they might call their own. Meetings were called in every school district and committees appointed to ascertain the true condition of every family and report to the county committee, which was provided with a contribution fund to provide seed and supplies for all that needed aid till something could be raised for the support of man and beast. With all the crops of wheat, rye, oats, flax, clover, corn, gardens and pastures consumed in defiance of every human effort to stay the general devastation (say up to the 1st of July), the fields being as bare as the public roads; the outlook was gloomy beyond description. Many gave up in despair and left the county.

The following from a correspondent to the St. Louis *Globe-Democrat* of May 28, may be taken as a fair statement of the condition of things:

But now, within a month they have become multiplied millions upon millions, traversing the whole country, spreading themselves in all directions, going to and fro; and I may safely say there is scarcely a square yard in the county which can claim exemption from their ravages. Pastures have been stripped of herbage, oat and wheat fields have been swept, gardens are bare of any growing vegetable, and the cornfields are alike destitute of indications that anything has been planted. The small fruits are irrevocably gone, and the larger fruits are now becoming a prey to their devouring powers. They swarm into the houses, hopping and climbing in every place that is not absolutely closed against them. No one who has not seen them can have a conception of their amazing number. They have been destroyed in all possible ways—by fire, by ditching, and various other modes—in bushels beyond computation, and yet they are the same ubiquitous host. So great is the dearth of anything upon which cattle may feed that they are daily being removed to distant counties and ranges where pasturage can be had. The condition of affairs is indeed gloomy, and much solicitude is felt in regard to the issue. Many are disposed to yield to despondency, but the larger number of our people are still resolute and hopeful. There will, of necessity, be many cases of destitution, but we hope to be able to provide for all such, and not apply for aid from abroad until we have exhausted our own resources. The situation is by no means desperate. An occasional field has been lightly touched, and the corn, which is the real staple of the country, though constantly eaten off as fast as the blade appears, it is thought has sufficient vitality to cause it to grow when the pest disappears, and even if it does not a fair crop may be secured by planting a quickly maturing variety even as late as the 1st of July.

A Farmers' Delegate Convention was held at Independence on the 26th of May, and was largely attended, 750 being present. They adopted resolutions reciting the destruction of all crops, fruits, meadows, etc.; that in consequence of the short crops of the two preceding years, farmers had not means to prevent suffering or provide seed for replanting; calling upon the people to meet in the school districts on the next Saturday, to make lists of persons needing aid; calling upon the county court to provide for such persons; appointing a delegation to visit the State Board of Equalization, and ask a reduction of fifty per cent. on the assessment of 1875; appointing a committee to wait on capitalists and banks and negotiate for money to pay for seed and relief; that the people of Jackson county will help each other to the utmost extent, and in case that is not adequate, will call on the Governor to convene the Legislature to provide further relief;

and, finally, appointing a committee to issue an appeal to the people of Jackson county, and discouraging all unlawful acts by sufferers.

An adjourned meeting was held at the same place on the 31st of the month, at which 150 delegates were present. The story of destitution recited that many were living on bread and water; trees were being cut down for food for cattle. A relief committee was appointed and donations were solicited from all who were able and willing to help. As a result of this movement about $5,000 to $7,000 were collected and distributed.

I spent some time in this county, and the gloomy outlook toward the end of May could not well be exaggerated. The stench from the immense numbers that were destroyed around Kansas City, was at one time unendurable, and lest it should breed a pestilence the authorities of Westport took measures to deodorize and disinfect the atmosphere on a large scale. Fifteen barrels of locusts were one evening shoveled up and hauled from the base of the court house at Independence, each barrel weighing 220 pounds. These were only a portion that were unable, after a hard days' battle, to get inside where there was a luxuriant growth of blue grass.

Johnson County.—The western portion of the county was most severely handled. In the vicinage of Kingsville it was estimated that four-fifths of all the wheat, oats, rye, corn, flax, meadow, wild grass and garden products were destroyed. At a meeting of farmers from Madison township held at Holden, June 2d, and presided over by the mayor, Hon. W. C. Smith, it was shown that the locusts had devoured all the wheat, flax, clover and timothy represented, together with half the corn. Potatoes were entirely ruined, and but little fruit, small or large, left. It was found necessary to drive live stock out of the county to localities more favored to prevent starvation. A large number of families were reduced to a bread and water diet. All were hard pressed to raise means for obtaining seed for replanting, and work teams were so reduced as to be scarcely able to perform their necessary tasks.

At the invitation of the county court, a delegate convention was held at Warrensburg on the 28th of April, all the townships in the county being represented. Dr. J. M. Fulkerson was elected chairman, and Rev. I. N. Newman, secretary. A committee of one from each township was selected to propose some plan for meeting the necessities of the county. The matter of relief was finally referred to the action of the individual townships. In some of the townships effort was made to effect large loans upon bonds given by the most responsible men in the community, the object being to sub-loan the amount

thus obtained, in smaller sums to those who possessed but little property, and yet sufficient to secure a note for such an amount as would be needful to supply their families and buy seed.

On three occasions, in May and June, I visited the country around Holden and Warrensburg, and publicly addressed the people at the latter place. The better class of citizens were determined and hopeful, and the condition of the county, judged by the payment of taxes, compared favorably with its condition in previous years, for in Warrensburg township $32,000 were collected out of $39,000.

LAFAYETTE COUNTY.—Although lying on the eastern border of the region visited by the locusts, this county shared largely in the general affliction and distress. A correspondent of the Chicago *Times* under date, Lexington, May 18, says: "The grasshoppers are on the move east, eating everything green in their road. One farmer south of this city had fifteen acres of corn eaten by them yesterday in three hours. They mowed it down close to the ground, just as if a mowing machine had cut it. All the tobacco plants in the upper part of the county have been eaten by them." Other advices show that many neighborhoods were rendered destitute, and the want of seed for replanting was widely felt. No public measures of relief were adopted, so far as I have any knowledge, and it is probable that none were necessary.

NODAWAY COUNTY.—In the St. Joseph *Herald* of June 3, there appears a brief item from Graham, Nodaway county, under date May 29th, as follows:

> We have some locusts here, but they are doing no serious damage to crops or gardens in this immediate vicinity. Five miles north of here there are no locusts. South of here, in Andrew county, they are numerous, and in places are destroying crops and gardens. West of here, in Holt county, they are not doing much damage, except in the west part of the county, where they are sweeping everything in places. Farmers are following after and replanting.

This county appears to have been singularly fortunate, a fact which may perhaps be accounted for by the large amount of timbered land in the county, together with its prominent undulations of surface.

NEWTON COUNTY.—Few eggs were laid in this county, and no serious ravages are reported.

PETTIS COUNTY.—Only the western part of this county suffered, and that not severely.

PLATTE COUNTY.—Under date May 25th, a correspondent to the St. Louis *Republican* thus describes the ravages of the insects in this county:

They have destroyed all the gardens in this vicinity, not sparing the onions or peas. The rose-bushes, instead of presenting one solid mass of bloom, look like so many bundles of sticks stuck about in the yards. They are materially injuring the young fruit trees as they climb upon them to roost, and during the night they cut off every green branch. The grapes have been cut the same way. In fact we have but little left. The pastures are full, and our farmers are sending their stock away to hunt grass. Some have felled trees for their stock to browse upon the green boughs. They have destroyed nearly all the corn and have been busy at work in the wheat fields, eating all the blades, leaving only the bare stalks standing. Every evening these stalks are crowded with the little pests, and it is feared they will destroy the bloom of the wheat, as they have nothing left upon which to feed.

Farmers drove away their stock to more favored localities, and for such as they were obliged to retain they cut down linden trees for feed. No concerted measures for relief are reported. The Platte City *Landmark* reports by the 24th of May, that the people had become more or less disheartened, and had about concluded that no effort of theirs could stay the ravages of the pests. Whole fields of wheat, corn, grass and most of the gardens in that county had been swept as clean of every green thing as if a simoon had blasted them. An army of the insects, about one hundred yards wide, attempted to cross Platte River, at Darnall's Ferry. For miles up and down the river the water was a living mass of them. Mr. Darnall at once summoned his whole force of farm hands, consisting of twelve men, who, with the aid of clubs and sticks, kept them from returning to shore, or crossing, until they became exhausted and floated off with the current. Mr. Darnall thinks that at least five hundred bushels were thus destroyed. He thus saved about one hundred acres of as fine wheat as he ever raised.

RAY COUNTY.—A gentleman residing at Richmond writes, May 23:

Since the reception of your note, I have been at some pains to gather the facts you asked for, and I send them in a shape as much condensed as possible. After riding about over the county for two days, and talking to reliable farmers who have been pretty much all over it, the truth learned seems about to be that we have been worse scared than hurt. The grasshoppers are not general over the county. In some places where they are they have eaten considerable, and in other places none at all. Myriads of them are dying. In some places so great is the mortality that the stench is sickening. Our general crop prospects are good. We have had fine rains. So far our grasshoppers seem to get no wings. From the places where they were hatched out to the places where they now are, the distance traveled won't amount to fifty yards. We are all hoping for the best, and believe the worst is over.

The following from the correspondence of the Kansas City *Times* shows the condition of things June 14th, nearly a month later:

The grasshoppers are still here, and doing a great deal of damage. They have left the high lands in places and gone to the bottoms. Thousands of them are daily flying away. A great many of them were seen flying on Sunday, from 11 A. M., to 5 P. M., going in a northwesterly direction. Great numbers of them dropped in Camden, and pounced upon the first green thing that came in their way. Crops continue to suffer; many farmers have turned their stock in on their wheat; oats are going every day, and young corn is badly injured, and in many places entirely destroyed. Farmers are almost despairing of a chance to replant anything. Tobacco plants are all

destroyed, as far as heard from. Hemp is badly injured. Fruit trees are suffering from the hoppers, as they are cutting off the young fruit and leaves, even dropping the young twigs to the ground, seemingly, to feed the weaker ones who cannot so readily get up in the trees.

The St. Joseph *Herald*, May 27, reports from Richmond, "that in some localities the locusts have taken the corn and wheat clean, and in other localities there has been little or no damage as yet. Some are planting their gardens and corn over, and think the 'hoppers' will leave the country before they can do damage to the second crop."

The Richmond *Conservator* of May 29, says, editorially:

Our exchanges are filled with accounts of the appearance and depredations of these pests; many of which are exaggerations, especially that report from Richmond, published in the St. Louis *Times* and *Dispatch*. The visitation is bad enough, we want it no worse; but, if accounts are correct, we have but few compared with the numbers in other counties. With but rare exceptions, no one has been seriously injured here.

St. Clair County.—Correspondence of the St. Louis *Republican* of June 3, shows, graphically, how great was the destruction and consequent destitution in the larger part of this county:

At the end of the war not ten buildings remained to mark the place of the once centre of trade. Even the court house was destroyed. The terrible sights of the cruel war are now being outdone by the cruelest of sights—starvation. For the past three years the crops of St. Clair county have been a total, or nearly total failure. Last fall the pangs of hunger stared many a strong man in the face, but with the assistance of help from the more fortunate he kept it at a safe distance only to return again with redoubled fury. Within the past few weeks cases have come to hand which excel and leave in the shades of night the thrilling scenes of battle and tender feelings generated by the tale of Indian warfare, where the scalping knife plays the most important part. Ten times more preferable would death be under the club of the savage than under the lingering cruel death of starvation. A true statement of events cannot, in fact, be better portrayed than is shown by a circular which is being circulated around the county, calling for a meeting of the citizens to devise some means whereby death can be driven from the door of suffering humanity. The following is a copy:

"Friends, you have been instrumental in relieving the most pressing wants of many of your citizens, and I hope you are still willing to aid them a few weeks longer, until they can be able to help themselves. Through the committee here there have been forty-four families aided. There are of that number now, perhaps one-half, who can get through upon their own resources, and the balance will need help.

"Friends, I appeal to you in behalf of suffering humanity, to do your duty in this case. If you could but see what I have seen, of the destitution of our people, you would not hesitate in this matter, but would gladly help the old and infirm, the crippled, the widows and orphans, whose cries for bread, bread, are ascending up to heaven. Will you respond to their cries? I believe you will. May God help each and every one to do his duty in this matter. I hope the good people of Osceola will call a meeting at once, at which time and place the truth may be made known and the required relief given."

This represents the destitution of but one town out of ten. The picture is unvarnished and put in as mild a form as possible. We have seen within the past week families which had not a meal of victuals in their house; families that had nothing to eat save what their neighbors gave them, and what game could be caught in a trap, since last fall. In one case a family of six died within six days of each other from the want of food to keep body and soul together. But it is but justice to say that the neighbors and citizens were unaware of the facts of the case and were not, therefore, responsible for the terrible death which overtook these poor pilgrims on their journey to the better land. This is, we believe, the first case of the kind which has transpired in this county; but, from present indications, the future four months will make many graves, marked with a simple piece of wood with the inscription, "Starved to death," painted on it. Our citizens have given, all that had any to give, until nothing is left to give, and now they must in their turn solicit aid from elsewhere. It would be more encouraging if the prospects for a fine harvest were at all flattering, but as the case now is, we do not hope for an excuse for a crop. The grasshoppers

have eaten up all the flax, all the wheat and corn, and now are attacking everything green, even grass, and three weeks will witness a country as barren as the grim deserts of Africa. We must have aid from some source or we shall perish. As I write this the sound of prayer and song is wafted on the breeze through the open window from the church across the way, as a crowded house, numbering some six hundred souls, are offering up, in answer to the proclamation of Gov. Hardin, their humble prayers for the interposition of Divine Providence to relieve the calamities which are falling with such fury upon this county. May the Lord, in His mercy, take pity upon this afflicted people and save them from the death which will surely overtake them unless a miracle is performed.

Vernon County.—Hon. William Hall, of Walker, writes, May 20: "We are in the midst of an army of insects. Between the grasshoppers and Chinch bugs this county is threatened with famine both for man and beast." From a correspondent of the St. Louis *Republican*, June 4, it appears that the ravages were chiefly confined to the northwestern portion of the county.

The other counties of Cedar, Dade, Daviess, Harrison, Hickory, Jasper, Lawrence, McDonald, Polk and Worth, that were visited in 1874, suffered comparatively little from the unfledged insects in the following Spring.

CONDITION OF THINGS IN OTHER STATES.

Kansas.—The ravages of the young locusts in this State, during the Spring of 1875, were confined to a district about 150 miles in length and 50 miles in breadth, at the widest, along the eastern border. The counties of Doniphan, Brown, Atchison, Jefferson, Leavenworth, Douglass, Labette, Johnson, Miami, Franklin, Linn, Bates and Bourbon suffered more or less severely. These counties comprised the principal hatching-grounds of the insect, for, although the invading hosts of the previous autumn had been reported as ovipositing in almost every county of the State, time proved that the great bulk of the eggs were laid as the locusts approached their eastward limit. In 1874 the greatest damage had been from northwest to southeast, being lightest along the eastern half of the State which the winged insects reached too late to do very serious injury. In 1875 the tables were turned; the eastern portion of the State suffered, and the western counties were little troubled.

A small proportion of the eggs, which had been deposited in dry, sunny situations, hatched during the autumn of 1874; but there is no evidence that any of the young thus prematurely brought into the world survived the Winter. On the contrary, certain experiments made the following Spring demonstrated the fact that a temperature of 2° below zero was invariably fatal to them.

The insects were reported as hatching in a few localities, and mostly along river bottoms, as early as the middle of March; but it

is the general opinion of my correspondents that all such early colonies perished from subsequent cold and freshets.

Prof. Snow, of the State University at Lawrence, records the fact of seeing the first young locusts upon the southern slopes of Mt. Oread on April 6th, and soon learned that a simultaneous hatching had taken place in many spots of bottom land, along roadsides and in fields of grass and grain. From this date until about the 10th of May they were reported from various localities as "still hatching."

Many citizens of the infested district labored with heroic determination to save their crops from the pests, and such efforts measurably succeeded in keeping them in check.

Continued wet weather and hail storms in some localities greatly reduced the numbers of the insects, and a large proportion also perished before acquiring their wings, from the attacks of various parasites.

From all the data accessible it would appear that the locusts first took flight in Kansas from the extreme southeast of the infested region, on May 28th and 29th, and that these swarms passed over the State in a northerly and northwesterly direction. At Ft. Scott they began flying on June 1st. At Lawrence the first winged locusts were observed May 30th and the first flight from that locality occurred on June 3d. At Chetopa they commenced flying June 5th; at Topeka, June 6th; in Worth and Jackson counties June 8th and 9 h. By the 13th of the same month they had nearly all taken their departure from Lawrence and the region southward, and by the 15th were gone from as far north as Leavenworth.

The testimony of a vast majority of observers is conclusive as to the general northwesterly direction of their flight. The few cases on record of their moving in other directions are attributable to strong adverse winds or to the fact that they were merely making short aërial excursions preparatory to the grand flight. It was noticed that when they flew to the south or east it was at a much lower elevation than when apparently returning to their native habitat.

The following interesting observations on their flight in Kansas are from an article by Prof. Snow, in Kansas City *Times:*

> The direction of their flight I have carefully noted. When the wind is strong they fly with the wind. If the wind is light they fly toward the northwest, by what seems to be a natural instinct. Thus on June 7th, with a southwest wind moving, according to the University anemometer, at the rate of three miles an hour the locusts were flying in vast numbers in a direction a little to the north of west *nearly in the face of the wind.* On June 12th also, with a northeast wind blowing at the rate of four miles an hour they were flying in greater numbers than ever before in a northwest course *at right angles to the direction of the wind.*

Having once taken wing, there are on record but two or three in-

stances of their alighting within the borders of the State. In these exceptional cases they remained but a short time, and, tho' creating much alarm, did but little damage—being far less voracious than had been the invaders of the previous Autumn.

There were no incursions into the State this year from the north or west, and after the middle of July scarce a specimen of *spretus* could be found in Kansas. The disappointed, but not disheartened, farmers went to work with a will, putting in late crops; the devastated fields and gardens renewed their green under the influence of frequent showers, and by Autumn there were but few mementos of the desolation of the previous Spring.

The amount of damage done to the early crops is difficult to estimate. During the prevalence of the plague it was doubtless considerably exaggerated, for even in the localities where the locusts were most numerous they seldom made a clean sweep of the crops, with the exception of garden vegetables and like succulent plants, for which they manifested a decided preference. In many instances they would completely strip one field, while perhaps the adjoining one would entirely escape.

Leavenworth county reported a loss of about 50 per cent. of the Spring crops; Doniphan lost 30 per cent.; Miami 25 per cent.; Brown 20 per cent., and other counties, where the locust injuries had been confined to certain sections, averaged a loss of from 10 to 15 per cent.

Census returns from sixty-two of the seventy-six counties show the total population to be 494,172. The remaining counties had a population, in 1874, of 41,905. If the returns for this year show an equal number, the population of the State will be over 536,000. Thirty-eight of the counties for which returns have been received show a gain in population, and twenty-three a loss. After such severe trials, this indicates an unusual prosperity; and it is worthy of remark, as illustrative of the enterprise of her people, that the fourth annual Report of the State Board of Agriculture, for the year 1875, is a volume of 754 pages, replete with valuable statistics, profusely illustrated, elegantly published, and edited in a manner that reflects great credit on its Secretary, Mr. Alfred Gray.

The report of the operations of the Kansas State Relief Society was completed during the Summer. It covers all the transactions of the committee in detail, from its organization November 19, 1874, to its disbandonment June 9, 1875. The amount of cash contributions received is given at $73,863.47, and the quantity of supplies at 265 car loads, and 11,049 separate packages. The estimated value of supplies is put at $161,245, which, added to the cash receipts, makes the aggre-

gate benefactions over $235,000. In addition to this, the United States have given nearly $100,000 in rations and clothing, and over $7,000 has been sent directly to the various counties from the east, and is not included in the committee's reported receipts. It is safe to say, counting everything, that fully four hundred and fifty thousand dollars in money and supplies were sent into Kansas since the 20th of November, 1874, for the relief of the locust sufferers. The largest amount of money was contributed by California, and the largest quantity of supplies by Illinois.

The following observations were made at the Signal Service Station at Leavenworth:

On the 6th of June last, the locusts were seen flying for the first time this year. They were flying north. At times, when the wind was due north and brisk, their direction would be apparently west, but a close observation would show that they retained their northerly direction. Large hordes could be seen flying almost every day for two weeks, but as they were flying at a great height, and also owing to the brilliancy of a summer sun, it was impossible to observe their size and thickness. On the 20th of June, those that were flying north disappeared. On July the 6th and 7th, two large hordes were seen flying southeast; with this single exception, the locusts were flying in a northerly direction in 1875. The locusts of this year flew apparently but a short distance north, and this is supposed to be due to the fact that they were destroyed by a small insect that could be seen in multitudes through a microscope upon the greater number of those that were full grown.

NEBRASKA.—The hatching grounds of the locusts in this State were limited to the district immediately bordering on the Missouri River, and a comparatively small area suffered from their attacks during the period of development. The populous and highly cultivated counties of Nemaha, Richardson and Otoe were most severely ravaged. In these a very large proportion of the Spring crops of all kinds were devoured by the young hoppers, while the attacks of the insects on nursery stock, following those of their progenitors of the previous year, entailed losses which it will take several years to repair. Portions of Adams, Cass, Lancaster, Seward, Josephine, Miller, Saline and Table Rock counties were also put under contribution for the sustenance of home-bred schools; but in these the damage was local, and, with a few exceptions, inconsiderable. From the data at hand it would appear that the insects hatched remarkably late, and it was not until about the 20th of May that their depredations became serious. As in Missouri and Kansas, the farmers energetically defended their crops by means of ditching, burning and coal oil traps. For the latter the insects seemed to have a great affinity, and once thoroughly immersed in the fluid, they were sure to die. Before the armies which had been bred within its borders were fully developed, Nebraska received transient but repeated visits from the migrating swarms of more southerly latitudes, on their way toward the northwest, and with

these it was much more difficult to contend than with those still unfledged. Reports of injuries by foreign swarms were received from the counties of Saunders, Washington, Douglass, Buffalo, Pawnee, Clay and Barton. In portions of these, corn and early vegetables were cut off, and wheat and rye bladed to some extent.

The brood which hatched within the State acquired wings and began to rise from the ground about the 7th of June. Their course, as with those from the south and east, was invariably to the northwest, except during the prevalence of strong adverse winds or absolute calms, and in such cases, they commonly alighted to await more favoring gales. By the 6th of July they were reported as about gone from the State.

The following observations were made at Omaha, and communicated by Mr. Myer:

The locusts made their appearance here on the 14th of June, about 10 A.M., and continued passing to the northwest until about 2 P. M., the wind blowing fresh from the south and S.S.E. The tail end of this swarm settled to the north of this city and a few of them returned to the south on the 15th with a north wind. Great numbers of them were destroyed by the hail and rain storm of the 17th.

Mr. Rosewater, editor of the "*Omaha Bee*," made inquiries regarding this swarm and states that it covered a tract of country 80 miles wide; 60 miles west and 20 east of the Missouri river. It went through a tract in Cass county 10 miles wide on the 13th. This was the only swarm worthy of note that was noticed passing here, though others may have passed unobserved: they sometimes move so high that they can only be seen by looking towards the sun.

The following are taken from dispatches to the "*Omaha Bee*," dated June 7, 1875:

McPherson, Lincoln.—A great many on the wing for several days; yesterday a great many going northeast.

Brady Island, Lincoln Co.—A few hatched out, many going northwesterly.

Columbus, Platte Co.—A few passed northwest lately.

Willow Island, Dawson Co. — No damage. Many on the prairie, including those hatched here. The air is full of them, having no particular direction but flying with the wind. None came down.

Kearney, Buffalo Co.—Going northwesterly.

Gibbon, Buffalo Co.—No locusts hatched; passed twice going north.

Kearney Junction, Buffalo Co.—Going northwesterly—large numbers came down May 30th.

Schuyler, Colfax Co.—Now and then a garden visited.

Nebraska City, Oteo Co.—Going southwest lately.

The following are from dispatches to the same journal, dated June 14, 1875:

North Bend, Dodge Co.—No grasshoppers in sight.

Valley, Douglass Co.—Going north since noon—none alighting.

Millard, Douglass Co.—Going north all day.

Silver Creek, Merrick Co.—Going northwest.

Gilmore, Sarpy Co.—Billions going north.

Elkhorn, Douglas Co.—Going north.

Chapman, Merrick Co.—Going north.

Lone Tree, Merrick Co.—Going north for two days.

McPherson, Lincoln Co.—Going northwest.

Gibbon, Buffalo Co.—Going with wind for last two weeks.

Schuyler, Colfax Co.—A few going north.

Grand Island, Hall Co.—Going northwest for the last few days.

In three or four of the counties where the young had most abounded and where migrating swarms had most frequently settled, the loss of crops was estimated at from 25 to 30 per cent., but averaging the State at large it did not, at an outside estimate, amount to 5 per cent., and according to the Omaha *Herald* of July 16th: "The local damages were more than equalized by the additional acreage under cultivation and the increased yield of all products in other parts of the State."

August 10th it was reported from Laramie City that vast clouds of locusts were flying southward; but nothing further was heard of them from any quarter.

Iowa.—Very few locusts hatched during the Spring of '75 within the limits of this State. On the 26th of May they were reported in considerable numbers in a few localities on the southwest boundary. The first serious incursions from the south were made about the 10th of June, and from that date to about the middle of July, the western counties suffered considerably from the swarms that were almost constantly passing over, many of which alighted and remained from twenty-four to forty-eight hours in a place, making sad havoc in corn fields, gardens and nurseries. Rye, wheat and oats were also damaged to some extent. From the counties of Mills, Tremont and Council Bluffs a loss of 25 per cent. was reported. Near Red Oak they settled in such vast numbers that the railroad trains were stopped by the oiling of the track with their crushed bodies.

Minnesota.—During the Spring of 1875 locusts occurred pretty generally throughout the western part of the State, especially in the region south of the Northern Pacific Railroad. They seem to have been most numerous and destructive in Blue Earth, Le Sueur, Nicollet, Brown, Sibley, Sterns, McLeod and Watonwan counties. In some of these counties generous bounties were offered for the bodies of the young hoppers, and a vigorous warfare was, in consequence, waged

upon them by the farming community, in which both sexes and all ages eagerly participated. A letter to the New York *World*, dated June 8th, has the following: "You can form an idea, not only of the energetic way in which the people have gone to work, but also of the magnitude of their task, when I tell you that two thousand bushels have already been paid for in this (Blue Earth) county up to last night, and they only commenced on Friday last." Taking the different counties together more than fifty thousand bushels of locusts were destroyed. By means of these vigorous measures from two-thirds to three-fourths of the crops were saved, while the price paid for the insects doubtless made some amends for what was destroyed.

A dispatch to the *Chicago Tribune*, dated July 13th, states: "The first foreign hoppers appeared on the Sioux City Road, aligbting between Lake Crystal and St. James on Wednesday last." A few days later they were observed at New Ulm, flying southeast, and at noon of the same day struck the line of the road at Madelia, St. James, Fountain Lake, Windom and Heron Lake; covering the track for about 50 miles of its length. They were described as being "uneasy, most of the time in the air, and, except in certain isolated or scattered fields, as doing but little damage."

From such data as can be procured it would seem that there were no invasions into the State from the original breeding grounds of the insect; but that the "foreign" swarms were from the States immediately to the south and west, and were probably deflected from their usual course by adverse winds. The soil and climate of Minnesota being peculiarly congenial to them, they deposited their eggs in prodigious numbers and probably died there. About the middle of August Gov. Davis appointed a commission consisting of J. C. Wise of Mankato, Warren Smith, of Graham Lakes, and Allen Whitman, of St. Paul, to investigate the history of the insect and its incursions; the purpose being to collect the most complete information possible, with a view to organized effort next year for the destruction of all locusts appearing in the State. The following letter from Mr. Wise, chairman of that commission, contains such interesting statements that I reproduce it, notwithstanding the complimentary allusions:

C. V. Riley—Dear Sir: I received copies of the *Rural World*, and as I take the *Prairie Farmer*, am also in possession of your equally valuable articles in the issues of the 11th and 18th. I have read your report, and your observations and descriptions are so very accurate that we shall draw largely upon them in making our report, for which full credit will be given. Indeed, you are so far in advance of anything else that I have seen that I feel that our State, and indeed the whole Northwest, owe you a debt of gratitude for your investigations of this very important subject.

You state correctly that while a few hoppers may hatch this Fall, the great bulk will not hatch until next Spring. We have heard of some hatching this Fall, but in our travels we have seen but very few. It was the same last Fall. A few hatched, and some were deluded by that fact into the belief that most of them would, and we should

escape injury. It was a delusion, for in the Spring when they began to appear, we were convinced that scarcely one in a million had hatched in the Fall.

In a recent trip to the region where eggs are now deposited, we found that in counties where eggs were first laid, the hopper is now formed, and with the aid of a glass the eyes and even limbs may be seen. In other localities the eggs are yellow and filled with a watery substance, which induces many to think that they are rotting, but which in fact is that condition incident to and preceding the formation of the insect.

This fact, however, was pretty generally and indeed invariably observed: That the glutinous fluid which matures and forms the coating to the sack has entirely disappeared and the eggs lie unprotected in the earth. We attribute this to the fact that the heavy rains have so moistened the ground as to dissolve that coating. This, we take it, is an unnatural condition, and, if so, there is ground for hope that the unusual dampness of the earth may assist in destroying at least a portion of the eggs. This condition prevails to such an extent that in all our investigations it was difficult to get out a whole sack, for they would break with the ground.

The hoppers that came into this county last year (1874,) came from the southwest. That was their course when they first flew, and when they commenced leaving they continued the same direction, northeasterly. This summer—the fore part of July—when they left us, they flew southwest, going in the direction from whence they had come, and in depositing their eggs have occupied about the same territory they did in 1873, though enlarging their limits. It was observed that nearly all of this year's hoppers had in the bodies a grub or worm such as you describe in your report, and to a greater extent than any previous year, causing them to die in large numbers.

Yours etc, JOHN C. WISE.

Mankato, Minn., Sept. 19, 1875.

The report made by this commission is an excellent digest of the subject, and by being scattered over the State will do much good. It places the amount of damage done in 1875 at two million dollars, and sums up the experience of the year as follows:

The eggs deposited in 1874, in the more northern counties of the State, began to hatch in April, and the young locusts were killed by the continuous cold and wet weather which followed, and damage is reported only in Becker and Todd counties. The eggs are also said to have been freely destroyed by grubs in Becker county. Along the Red river but few eggs were laid, and along the Mississippi they hatched in too widely distributed localities to have any great effect on the general crop.

The chief damage of the year was done by locusts hatched in the counties of McLeod, Sibley, LeSueur, Nicollet, Blue Earth, Brown and Renville. The hatching progressed through May as usual, and in spite of the warfare waged against the locusts, the damage was great throughout all the counties named. The departure began about July first, and by the tenth of the month it became general throughout most of the districts ravaged. A fresh northwest wind would have carried the greater portion of the locusts hatched in Minnesota far beyond the borders of the State, but after struggling awhile against a southwest wind they settled down upon the fields and continued their ravages. During the remainder of the season they inflicted serious damage upon Jackson, Martin, Murray, Cottonwood, Watonwan and Redwood counties, and slighter damage upon Nobles, Rock, Lyon and Lincoln. By the end of August the locusts had mostly disappeared in one way or another, and the earliness of the disappearance has been accounted for by the action of parasites, which infested the locusts abundantly

The following observations were made by the Signal Service operator at Breckenridge:

The locusts were seen during the month of July and a part of August, until about the 12th; the first seen came from the southeast, and nearly always moved with the wind, especially if strong. During the month of July they were flying almost every day, and at times the swarms were so dense that it was impossible to see through them with a good field glass.

The farmers state that their flying was so regular that no one paid much attention to it; at times the swarms would be more dense than at others, especially if almost calm. Several persons who watched them say that they think they laid but few eggs in the soil this year, and predict few for the next summer.

It will be well here to reiterate the fact that the Rocky Mountain

Locust is sub-alpine, and breeds in greatest profusion in the Rocky Mountain region of the extreme northwest. It thrives best in a high, dry, cold climate, where the summers are short but sufficiently intense. By bearing this fact in mind, we may understand why Minnesota suffers more frequently from the pest than do Iowa, Nebraska, Kansas or Missouri.

The records show that the insect occurs much more frequently in that State than it does further south. Minnesota is unfortunately nearer to the insect's native habitat, and the pest not only extends further east in Minnesota than in any other State (having been known to reach as far as Lake Superior,) but it holds its own better in that climate, and does not so soon succumb to disease and enemies, or so soon leave, as with us.

COLORADO.—This territory, always more or less subject to the locust scourge, was, during the spring of 1875, put under unusually heavy contribution by the insects which hatched in its most highly cultivated sections.

The *Colorado Farmer* for May 6, gives the following account of the situation:

> The locust plague is fairly upon us; the locusts have hatched out in countless millions, and have gone through the early garden and farm crops. From all parts of the territory the cry of "the locusts are upon us," comes with startling force, making strong men quail and women weep.
>
> North and south, from the base of the mountains out to the verge of the plains, the pestiferous locusts have commenced their hateful work. Want and penury stares men in the face who have invested their last dollar in putting in a crop. Eaten out last year, the bouyant hope that has ever characterized Coloradans, induced another trial this season, but it will hardly be possible to tide over the present fearful set-back.
>
> There are, however, some redeeming features; the hoppers can't stay with us always, and they have already commenced to move in a southeasterly direction. Farms that are suitably protected by irrigating ditches are not harmed; wherever the ditches have been filled, nearly all the hoppers that have attempted to cross have perished in the trial. The hard earned experience in the past of Colorado farmers has developed many plans for the destruction of the pests. Among these plans, in addition to the water plan, is destruction by fire—burning straw, in which they seek shelter by night; the use of machines to gather them, and systematically driving them into running water.

The date of hatching varies with the elevation. Mr. N. C. Meeker, of Greeley, writing the latter part of August, says: "On the plains they appeared late in April and the first of May; along the foot hills in May; in the timber region and along the Snowy Range, from June to July. * * * About the first of July the first hatched in the plains region departed torward the south. A week ago, (Aug. 20th,) those hatched in the Blue Mountains came down upon us and then departed in a southeasterly direction, but now we are having them from the Snowy Range in what seems incredible numbers. Their numbers, however, are almost nothing in comparison with the myriads that keep southward every day about noon. I estimate that they cover in

the sky east and west a space 20 or 30 miles wide, while they move in a body half a mile deep. They consume about two hours in passing, and one can estimate from this statement how much ground they would cover if they should all alight. * * * *

"Colorado has something like half a wheat crop of most excellent quality, and it is sufficient to provide bread. The deficiency arises wholly from the destruction of crops by the locusts, which hatched a month earlier than common. If they had hatched out at the usual time, the crop would have been a full one, because the wheat would have been too far advanced in growth to have been injured. Thousands of acres of corn were planted in the ruined wheat fields, and the earliest planted is likely to yield well, but with these millions of locusts around us everything is uncertain."

In November a correspondent of the *Colorado Farmer* wrote that "the young locusts were hatching out in great numbers, and that the eggs deposited during the present season were so far advanced toward hatching that large numbers would be destroyed by frost during the Winter and Spring."

Signal Service observations made at Denver show that from the 20th of July to the end of August, swarms repeatedly passed and invariably from the north and northwest, notwithstanding that the prevailing direction of the wind was from the south.

DAKOTA.—Observations made at Pembina and communicated through A. J. Myer, chief signal officer, show that the young locusts began to make their appearance, or to hatch from eggs laid the previous Fall, about the first of June. They matured in about six weeks. The general movement of the winged insects was south, though at times southeast.

About the 10th of August they were seen in incalculable numbers going south, the atmosphere being thick and clouded by them as far as the eye could penetrate, seeming miles in height.

Long before this, however, the insects which left the country to the southeast early in June, passed over the territory in a northwest direction, as the following special dispatches to the Sioux City (Iowa) Daily *Journal*, kindly furnished by Mr. Wm. R. Smith, of that place, will show:

FORT THOMPSON, June 28.—Large clouds of grasshoppers passed over this place to-day, but did no damage. They came from the southeast, and if they maintained their course would bring up in the bad lands of northwestern Dakota and Montana, where their presence will hurt nobody. It is to be hoped they will not light short of that locality.

YANKTON, June 28.—This section is still free from injury by grasshoppers, although many of our people lost heart to-day on seeing the myriads of pests carried

along high in air by the wind. Fears were entertained that perhaps something might stop their flight, but as yet we hear nothing of their coming nearer than within eye-shot.

YANKTON AGENCY, June 28.—The hoppers have come and gone without doing damage. Vast swarms passed over this place to-day going in a northwesterly direction, but happily did not light.

FORT SULLY, June 28—Light clouds of grasshoppers passed over here to-day moving in a northwesterly direction. They did not light and consequently no damage is reported.

FORT RANDAL, June 28.—No damage here from grasshoppers to-day, notwithstanding the air has been full of them flying in the direction of the Whoop-up country.

SPRINGFIELD, June 28.—The grasshoppers went over here to-day, evidently heading for Montana. We are pleased to say that they didn't stop here for luncheon.

Mr. Myer also sends me the following interesting observations made at other points in the Territory by the different signal officers:

BISMARCK.—Locusts first made their appearance in the vicinity of this station on June 6, 1875, and infested this district from that time until the date of their final disappearance, July 15, 1875.

They first made their appearance on June 6, 1875, but not in such quantities as to excite remark—coming from west and southwest; with surface wind fresh to brisk from northwest and weather hazy. On June 7th, during the morning, their numbers perceptibly increased, flying from the South, in small swarms, eight or ten feet thick, with the surface wind west and southwest. During the afternoon with gentle south wind the grasshoppers rose and flew north; very few being visible near this station that night.

On June 8th they returned gradually from the north, and for the first time began to eat the crops, and during the day were reinforced by a light swarm from the southeast—surface wind from west and northwest. Remained during June 9th, eating but little. On June 10th a storm of wind and rain from the east swept over this station, which appears to have dispersed them, very few being seen in this vicinity until June 29. On that date, a small swarm, estimated as being about five hundred yards square and from ten to twelve feet thick came from the south, the surface wind being from the northwest. This swarm settled but did no damage that I could hear of, and no more arrived until July 7th. On that day a swarm made its appearance before which the previous visitations sank into insignificance. The day was very warm with hazy weather and gentle south winds. At 10 A. M. the locusts were first noticed on the southwest bank of the Missouri river, and in such quantities as to resemble heavy banks of stratus clouds. They passed over this station, without intermission from 10 A. M. to 4 P. M., with a peculiar "whirring" noise caused by movement of so many millions of wings. It was almost impossible to estimate the extent and thickness of this swarm, extending from twenty feet above the ground, high into the air, probably two hundred feet; and as far as the eye could reach to any point of the compass, the air was full of the insects. At 4 P. M. they began to settle on the ground and by nightfall the ground was covered with them.

On the morning of July 8th another swarm estimated to be about half as large as the one mentioned above, came with the surface wind from southwest, and settled on the ground with their predecessors.

During the 9th and 10th July, the locusts devoured nearly everything green in this vicinity, and inflicted great damage to all crops except potatoes, in which the loss was estimated to be 25 per cent. Cabbages and turnips were almost wholly destroyed. The total damage done to all crops is estimated at 60 per cent.—excluding the potato crop. Had all the crops been ripe at this time, a total destruction would no doubt have ensued.

After July 10th, the locusts rapidly became less, many dying and the balance slowly moving north and west; and after July 15th, they had wholly disappeared.

YANKTON.—On June 17 the wind was strong from the east; the locusts were going with it to the west. On June 28 the wind was moderate from the south. Great swarms of insects were going with it north. On June 29 the wind was northeast, moderate. A good number of locusts were traveling southwest.

FORT SULLY, June 15th.—[Direction of wind, as ascertained by the records: 6 A. M. to 7 A. M. northeast, then east till 10 A. M., then south till 3 P. M.; southeast remainder of day.] Several days previous to this date I had been hearing of the approach of locusts along the line of telegraph from Omaha upward to northwest, and at 4 P. M. of the 14th the operator at Fort Thompson (85 miles south, 25° east from Fort Sully) reported their advance flying northwest and northwardly. At noon a large cloud of the insects passed over until night when they were no longer visible. Roughly estimated the swarm may have been about 50 miles long, 25 wide and ¼ to ½ mile in height. A hail storm the following day may have dispersed them.

June 23.—[Direction of wind: 6 A. M., southeast; 7 A. M., southeast; 10 A. M., southeast; 2 and 3 P. M., east; rest of day calm.] Large flights of locusts passing over during the morning, going north and northwest at an estimated elevation of about 50 feet to as high as they were visible with field glasses, possibly a mile; none alighting. This swarm, as near as could be ascertained by telegraph at the time, came from the Minnesota infested region along the line of the Sioux City and St. Paul Railroad in a continuous cloud, probably 1,000 miles long from east to west, and 500 miles from north to south. How much farther north of this post, unascertained, and not conjectured.

June 24.—[Morning calm; west wind at noon, followed by southeast in evening and night.] Straggling locusts began to fall, the flight still continuing northwest. During the afternoon they commenced to alight and the post garden vanished from the earth. Their increasing numbers resembled smoke at a short distance, many thinking there was a large prairie fire, the resemblance being very close.

June 25.—[Wind north until night, then southeast.] Locusts so thick along the bottom land as to hide the ground in places. Prairie also covered with them. Large numbers still flying. In some places they drifted into disgusting heaps, from six inches to a foot in depth, and where trodden upon by horses, etc.; they rendered those locations very uninviting in appearance and odor.

June 26.—[Wind east till 3 P. M.; then northeast, and at night north.] Remaining as the day before.

June 27.—[Wind north till 3 P. M.; southeast at night.] Began arising.

June 28.—[Wind southeast till 10 A. M.; west at 2 P. M.; north at night.] Disappeared from ground and by night none were seen in the air. They flew away northwest.

August 6.—Large numbers passed over but less than on previous occasions, (stragglers fell) passing northwest.

August 7.—Still passing northwest.

August 8.—Same swarm going northwest. A severe thunder storm arose and about 8 P. M. hailstones fell. When this storm passed the last locust seen this year had fled northwest.

MONTANA.—I have been unable to obtain any satisfactory data from the editors of any of the journals published in the Territory, all of whom I addressed with stamp enclosures. The tendency is so great among such to depict the Territory an Eden with no drawbacks, that they invariably claim to be out of the line of the locusts. The following observations were recorded at Virginia City in the extreme southwest of the Territory, and received from Mr. Myer. After stating that the insects moved west on the 18th of July; a little south of west on the 19th; southwest on the 20th, 21st and 22d, and southwest on the 7th of August; and that the wind was from northeast and southwest on the 18th, west and southwest on the 19th, southeast and northwest on the 20th, east and northeast on the 21st, southwest and west on the 22d and northwest and west on the 7th of August, the observer continues:

The locusts were thickest on July 20th and 21st, giving the sun a hazy appearance.

These "emigrant" locusts came from the plains of Dakota, and were here, the largest bodies on the above mentioned days, at least half a mile in thickness, and, as I learn from reliable authority, they presented an unbroken width of twenty miles, being even more numerous on the wings than here, near the centre.

A great many stopped here on the 20th, clinging to fences, etc., as if exhausted. They were numerous around Helena, Bozeman, Deer Lodge, and other towns in that portion of Montana Territory, the general course taken being southwest.

The following observations, received from the same source, were made at Benton:

Large quantities of locusts devastated the country west of this place, but there being no arable land nearer than Sun river, sixty miles distant, they were not so plenty here, although large quantities were at this place during July and August. They moved principally southwest and northwest. The wind was principally west, and the swarms at Sun river large enough to darken the sky. I find no mention of them in the journal except on July 27th and 28th, and that states that they did not seem to be traveling in any particular direction.

WYOMING.—Signal Service observations made at Cheyenne, show that the young locusts were very numerous during the latter part of May on bottom lands; and the observer records the following somewhat later in the season:

August 6th. A number of locusts were seen moving south; wind from northeast, at P. M.

August 8th. A great many locusts were observed at 2 P. M., moving from northwest; apparently carried by the northwest wind, they moved to the southeast.

August 23d. An immense swarm of these insects alighted from east to southeast, apparently compelled to by the brisk northwest wind.

August 24th. Most of the locusts left to-day, moving west and northwest; wind being light to fresh from north to south. I noticed a few, upon my return to the station, September 30, and October 1.

I did not learn of any serious damage from these pests, owing, I suppose, to the fact that agriculture is not carried on in our vicinity.

A series of questions, as to the course of the insects, which I published in the Daily *News* of Laramie City, failed to bring me any answers.

TEXAS AND INDIAN TERRITORY.—The insects are reported as having hatched in large numbers early in the Spring in Northern Texas and Indian Territory; but while gardens were often ruined, little damage was done to the growing grain. The Signal Service officer at Fort Gibson, I. T., reports that—

There were three distinct swarms seen about the first of May; the exact date I am unable to ascertain. They seemed to have had their origin from a deposit of eggs during the preceding year, and left the neighborhood as soon as they were able to fly. The first two lots moved toward the northeast, with the surface winds blowing from the south; the third swarm, on the contrary, moved towards the southwest, with a northeast wind.

They were leaving during most of the month of May, and generally north. A dispatch from Fort Gibson, dated June 1, says:

Millions of locusts essayed their new wings on Sunday, rising like swarms of bees and started in a westerly direction. The air was filled like a cloud over the sun at ten o'clock. The Grand, Verdigris and Arkansas rivers were covered with the dead hoppers that failed to fly across at the start. We bid them adieu without a pang of regret.

They were not noticed as far south as Corsicana, Texas, but were observed to be numerous at Dallas, sixty miles to the north.

MANITOBA.—Little or no cultivation was attempted in many parts of Manitoba, owing to the prevalence of locusts in the Spring. Mr. G. M. Dawson, in an interesting pamphlet "on the Locust Invasion of 1874 in Manitoba and the Northwestern Territories," just published in Montreal, remarks that "the position of Manitoba, near the north-eastern limit of the range of the locust, is in so far favorable as it is only exposed to invasions from directions included between west and south; and the prevailing winds being northwesterly and coinciding with the direction of the migration instinct of the insect, carry the greater number of the swarms from their breeding places to the South-western States. The northern situation of the province also tends to exempt it from a double visitation, first from southern, and then from northern and northwestern broods." He states, however, that the number of the insects borne to Manitoba, is more than sufficient to produce great injury.

AMOUNT OF DAMAGE DONE IN MISSOURI.

In making an estimate in figures of the amount of damage done by the locusts, several important considerations must be kept in view. First, it is impossible to arrive at strict accuracy, for we have no such means of collecting facts covering a whole county, as would enable us to ascertain the exact damage upon each farm or quarter section. Then, the amount of injury to fruit and gardens, and the permanent injury to fruit trees, meadows and pastures, can scarcely enter into our calculation. The number of improved acres varies in counties of nearly the same area. Different counties received different measures of harm, owing to the different character of the surface, the relative amount of timber, etc.

The immediate damage was the loss of labor expended in planting, and the seeding for about two-thirds of the crop acreage of the country, to which the destruction of the tame grasses and of fruit may be added. The value of these it is difficult to get at. I have requested a number of correspondents to give an estimate of the probable damage in their county from the young locusts, and I append a few of the answers as samples, from counties which received the greatest injury. Many find it impossible to make an estimate, while a few deem that their counties, for one reason and another, were not materially injured by the locusts.

The loss to Lafayette county was fully two millions of dollars.—[J. BELT, Napoleon, Lafayette Co.

I estimate the damage done in this county to be at least 50,000 dollars.—[ELIHU CANADAY, Ionia City, Pettis Co.

The damage in our county was not very heavy, as the insects hatched late, when there was already abundance of vegetation to feed upon, and they did not spread over the whole county. There were none east of Sedalia, while they were numerous south, west, and northwestward. I do not think the damage in the county amounted to over $50,000 in all, while their depredations created a demand for much of our produce further west.—[GEORGE HUSMANN, Sedalia, Pettis Co.

The damage to our county by the young locusts in the Spring of 1875 would not fall far short of seventy-five thousand dollars. — [JNO. L. MODREL, Little Osage, Vernon Co.

I suppose half a million dollars would be the lowest estimate that could be given. —[J. L. MOTSINGER, Fayetteville, Johnson Co.

The damage was immense. Our county will not get over it for years. Nearly one-half of our farmers are bankrupt. Deeds of trust are on one-half of the lands.—[B. F. Dunkley, Dunksburg, Johnson Co.

The damage done to the three-fourths of Lafayette county invaded, has been estimated to be not far from two and one half millions ($2,500,000). — [JAS. E. GLADISH, Aullsville, Lafayette Co.

$2,380,000. In making an estimate of the loss to the county from ravages of locusts, I would state that we put it at the very lowest figures from actual calculations. —[Dr. Jno. L. GREGG, Stony Point, Jackson Co.

If I had the statistics showing how much clover and timothy was destroyed, how much oats and wheat, and how much of the same was planted in corn, and what the average crop raised in comparison with what would have been the average if the earlier planting had stood, and also to what extent the soft corn is being and will be utilized —if I had a perfect knowledge of these things I might make an intelligent answer.—[W. S. PARRISH, Hickman Mills, Jackson Co.

The damage to Jackson county in the Spring of '75 would exceed two million dollars.—[Z. S. RAGAN, Independence, Jackson Co.

To enumerate by counties, the following figures approximate the real loss sustained from the injury to grains alone:

Atchison $700,000; Andrew $500,000; Bates $200,000; Barton $5,000; Benton $5,000; Buchanan $2,000,000; Caldwell $10,000; Cass $2,000,000; Clay $800,000; Clinton $600,000; DeKalb $200,000; Gentry $4[illegible]0,000; Harrison $10,000; Henry $800,000; Holt $300,000; Jackson $2,500,000; Jasper $5,000; Johnson $1,000,000; Lafayette $2,000,000; Newton $5,000; Pettis $50,000; Platte $800,000; Ray $75,000; St. Clair $250,000; Vernon $75,000; Worth $10,000.

The foregoing estimates exceed the amount of $15,000,000. They are arrived at, in the majority of instances, by combining the following elements: the number of acres of crops destroyed; the average amount of the crop; and the value of the crop, allowing forty cents a bushel for corn, one dollar for wheat, one dollar and a half for barley, and thirty cents a bushel for oats. The amount of loss redeemed by crops that succeeded after the insects left, it is impossible to determine; and yet this amount may again be offset by the injury both temporary and permanent, to fruit, fruit trees, vineyards, gardens, meadows and pastures; by the fact that such crops as

flax, castor-beans, etc., have not been estimated in the calculation; and lastly, by the injury to stock, the animals necessarily driven out of the country, and the general depreciation of property. The counties of Cedar, Dade, Hickory, Lawrence, McDonald, Nodaway, and Polk, have, moreover, been omitted from the calculation, for want of sufficient data on which to base estimates.

THE DESTITUTION IN MISSOURI.

From the facts already detailed under the heads of the different counties, it will readily be inferred that the same portion of the State has never before been visited by a calamity so appalling, and so disastrous in its results, as the locust ravages of 1875. Other years have brought drought, chinch bugs, and partial or total failure of particular crops, but no event ever before so completely prostrated the country within which the ravages occurred. The suddenness and desolating power with which the attack came, where often the possessor of promising crops deemed them safe, acted as a paralysis upon those very faculties that are engaged in the forethought and deliberation necessary to self-preservation or concerted action. The farmer saw his green acres smiling with glorious hope to-day, and to-morrow, perhaps, all barren and bleak as in winter. It is no wonder that many communities were panic-stricken. Previous disaster had already brought many sections to a critical and suffering point, so that even during the winter the Legislature was appealed to for aid. Stock had been dying; feed of all kinds was scarce, and whole communities were relying on the promise of the Spring. For this reason the locust ravages were all the more desolating and discouraging. I subjoin a few extracts as a record of the destitution that occurred:

It would be useless for me to attempt to describe the ravages of the grasshoppers. You can form some idea of their voracity from the fact that they have eaten lint and decayed wood from the fences, and unpainted houses are gnawed all over, and they are now consuming the last year's corn stalks. In addition to our present disasters, I fear that disorder is not far away. There is an uneasy, if not desperate feeling in many localities, and those having provisions are secreting them. The press is not telling the whole truth. A few nights since a body of armed men, who said they were from Bates county, took all the flour from the Kingsville mill, and it has not been published. Many other ugly facts are suppressed.—[Extract from a letter from Abram Helms, of Holden, to H. M. Williams, Jefferson City.

We must have aid, or many will be compelled to abandon their crops. We have not the seed to plant with, or the money to buy. Season too far advanced for anything except corn, late potatoes, navy beans and millet. Can you help us by donation or loan. The condition of our county is truly alarming. People have become discouraged; many are talking of leaving their homes; some are living on bread and water. Unless we get assistance from some quarter, many are bound to suffer. Holden and East Lynn are our shipping points. Can get better rates to Holden than any other place convenient.—[Letter to Master T. R. Allen by a committee appointed at Altona, May 25.

I am now out of funds, while the distress is more imminent than at any time since we began our relief effort. From Benton, Bates, Cass, Johnson, Henry, St. Clair, and from Lafayette and Jackson counties, the appeals are most urgent and pathetic.—[Extract from a letter, May 21, from State agent A. J. Child to T. R. Allen.

From Galbreath's store, Henry county, comes the statement "that there are many families who will actually starve if they are not assisted." The agent of the State Grange, A. J. Child, who has been distributing corn supplied by the grange, writes from Appleton City, St. Clair county: "It grows worse and worse, and God only knows what the future of many of these inhabitants is to be. They are out of everything and have exhausted every available means of credit in their efforts to live and get crops started, and now the chinch-bugs and grasshoppers are cleaning up everything like a consuming fire. I am overpowered and overwhelmed by disclosures of the fearful want, and the equally fearful outlook." Judge Woods, of the Henry county court writes: "I cannot see how our people are to get through the next two months, as there is not enough bread-stuff in the county to keep them from starvation. If it were here, they have no money to buy with. Those who had a little corn had to feed it in order to save their stock, and now they are out of corn, money and credit. Hundreds are living on bread and water." A letter from Kingsville, Johnson county, says: "The condition of things in the western part of our county is perfectly distressing. Men are growing desperate, and already threaten to divide out by force what there is in the county, and we all know that when such a move is once made, the worst men in the county will take the lead."—[*St. Louis Republican*, about the middle of June.

I do not exaggerate, but state the simple truth when I say that I have been time and again over the most of this (Polk) township, and I do not believe there is *one sprig* of timothy, clover, wheat or corn left standing an inch above the ground in the township; that not a bundle of oats will be cut; not a pound of hay or grass of any kind will be saved this season; vegetables of every kind have been totally destroyed, and all the fields, without a single exception, so far as I have been able to learn, are as bare of vegetation, even weeds, as newly ploughed ground—notwithstanding the fact that some farms have been planted as often as twice and three times this season, and the wild grass and weeds on the outlands in both prairie and timber, have either been entirely devoured or cut down so close to the ground that cattle have been and still are starving to death by hundreds. The owners having in many cases paid out all their money, sold everything they could get along without, and mortgaged their farms to get money to carry their stock through the winter and plant their crops, now are left with nothing to eat, their stock have starved to death, and they have no money, and no means of raising any by loan or mortgage, to buy food or to get away from here to more favored sections of the country.—[*Globe-Democrat* Correspondence from Strasburg, Cass Co., June 16.

My own impressions received at the time, may be gathered from the following remarks made at a meeting of the merchants of St. Louis, held at the Merchants' Exchange, May 28, for the relief of the destitute, and reported in the St. Louis papers:

I have just returned from the district of Pettis, Johnson and Cass counties, and from reports I have had from Vernon, Bates and Johnson counties, I can form a pretty correct conclusion as to the actual state of things there. One reason why reports are so contradictory is mainly because you will find districts in the same county very differently affected. I believe that Cass county is about the worst off, and actually the devastation by the locusts in that county cannot be exaggerated. You may go from one end of that county to the other, and with the exception of forest trees, where there is timber, and here and there a low piece of moist prairie, or occasionally an oat field, there is not a trace of vegetation to show you that it is the growing season; the country is as bare and desolate as in mid-winter. The only vegetation remaining in the fields consists of a few stalks of milkweed (*Asclepias*), which is about the only conspicuous plant they do not relish.

Very much the same state of things occurs in the adjacent counties, and the distress is great.

I find among the people in the stricken district generally a determination to overcome the difficulties, and, as far as possible, to relieve their own people. The well-to-do citizens feel inclined to relieve their own counties as far as possible, and with few exceptions there is no actual distress. The greatest want is mainly on account of the scarcity of seed. Some families will need rations and food to keep them from starvation until they can bridge over the present destitution, but as a rule the need is mainly for seed for the different crops. They need corn that will mature early, buckwheat, Hungarian grass, vegetable seeds, potatoes—everything that will soon mature, and this they want immediately.

It is impossible to say how long those sections in the several infested counties, which are now in a flourishing condition, will remain so. The probabilities are that

during the next week most of the crops in those sections will be destroyed, and that they in the end will suffer more than the counties which have so far suffered most. There has been a great deal of talk among a few idlers and loafers and desperate characters, of raids on the towns and on those who have supplies. But the committees appointed, especially in Johnson county by authority of the County Court, investigated the real state of affairs, and have reported that there was really no actual destitution in that county, and that all these threats were made by desperate characters, who would not work if they had the chance.

Efforts are now being made to relieve this pressing necessity for seed. I am confident that the prediction I have made will be verified. The people will yet raise in those counties, in all probability, the largest crops of corn they ever raised. The locusts having killed off the herbage from the ground, the hosts of noxious insects that fed on it have also been annihilated. There is not a weed left, and the ground is in the best possible condition to receive seed. By the time it comes up I believe the insects will have been decimated by parasites and starvation, so that the crops will receive little injury; that the insects will not materially advance beyond the eastern line they have now reached. Already they are dying in immense quantities; and they will soon acquire wings and leave. Thus the fears of some that they threaten to be a permanent pest, and that it is of no use to plant because the insects will eat everything as fast as it comes, are groundless.

I would urge all farmers to put forth their best efforts to plant seed for such crops as will mature soon. I would especially urge the planting of more root crops, such as turnips, beets and mangel wurzel, which will furnish nutritious food for stock. We must not forget that the area now being devastated, compared with the area overrun last fall is small, and the present severe devastation is confined to some dozen counties, whereas in the rest of the State the crops are promising most abundantly. I really hope that no aid will be asked outside of the State.

There are a number of ways in which the insects can be destroyed. By means of ropes, conveying screens and nets, they can be caught in large quantities. They may be trapped in ditches. If it had been possible for Governor Hardin to offer a bounty for every bushel of the insect, that could have been captured throughout that district, it would have afforded employment to hundreds of people who have now nothing to do. From a conversation I had with Governor Hardin, I am of the opinion he would gladly have taken that step. When I suggested last winter that a law should be passed offering a bounty for the eggs, the idea was ridiculed, but the people see now how wise such a course would have been. A few thousand dollars appropriated by the Legislature for the purpose would have been the means of averting the present injury.

The meeting above referred to resulted in the appointment of a committee by the Directors of the Exchange, for the purpose of soliciting aid; and the committee at once issued the following circular:

ADDRESS OF THE COMMITTEE.

The undersigned, a committee appointed by the Merchants' Exchange, and acting under the advice of the Governor, to appeal to the charitable people of St. Louis, and the State of Missouri at large, in behalf of our fellow-citizens of the counties of Cass, Vernon, Henry, Bates, Jackson and other border counties of the State, now infested and overrun by locusts, beg leave to submit the following suggestions: From conversation and correspondence with numerous parties whose statements can be relied upon, we are convinced of the *great necessity* for the immediate relief of these people. The demand is more especially for seeds for replanting to enable them to subsist during the coming winter.

The committee beg leave to recommend that the people of other cities and counties in the State organize local relief committees to co-operate with this committee, or send supplies directly to the committees appointed by Governor Hardin. Supplies or money sent through this committee will be strictly applied to the relief of the destitute, under the supervision of proper and responsible sub-committees.

The committee are satisfied, from information obtained through Prof. C. V. Riley, State Entomologist, that the insects will not extend far beyond their present limits, and that they will gradually disappear from the counties now infested—the great demand being for immediate and present relief.

Donations are specially asked for in the following *seeds*, viz.: *Early corn* (grown as far north as possible), *millet*, *Hungarian grass*, *rye*, *oats*, *buckwheat*, *beets*, *turnips*, *mangel wurzel*, *potatoes*, *cabbage*, *tomatoes*, *sweet potato plants*, *peas*, *beans*, *broom corn*, *sorghum* and other garden seeds in season. Food—Corn meal, flour, cured meats and salt. Forage—Corn, oats, hay and any other forage for stock.

Donations in any of the above articles may be sent to the Central Elevator, corner of Twelfth and Austin streets; Pacific Railroad track; Henry Ames & Co., No. 1001 North Main street; E. M. Samuel & Sons, Levee and Vine; or W. M. Price & Co., No. 14 South Main street. On notice left with any of the committee, donations will be called for.

John M. Gilkeson, Chairman,	L. L. Ashbrook,
Joseph A. Wherry,	Samuel M. Dodd,
John T. Davis,	W. R. Jouett,
Miles Sells,	R. M. Adams,
Jos. S. Nanson,	Webb M. Samuel,
John W. Larimore,	T. G. Conant,
A. H. Smith,	C. O. Dutcher,
John B. Maude,	Thomas Booth,
Ch. Bartlett,	W. M. Senter,
W. P. Howard,	W. M. Price,
D. W. Marmaduke,	Committee.

It is hardly necessary to state that the Committee did not cease its efforts till the 22d of June when there began to be no further occasion for them. The sympathies of our citizens were aroused and large amounts of supplies of all kinds, and especially of seeds were at once sent out to the stricken districts. Aside from the good relief work done in other favored parts of the State, outside St. Louis, the efforts of T. R. Allen, Grand Master Patrons of Husbandry, are particularly worthy of mention. He took an active part, and deserves the thanks of the people. He traveled through the more fortunate sections of the State, and personally plead for the sufferers and solicited subscriptions, and in this way succeeded in doing much good.

Some cases of actual starvation were reported in the papers, but I have been unable to learn of a single authenticated instance where the names of parties could be given. Replies to the question, "Did any cases of actual destitution or starvation positively occur in your county?" from over a hundred correspondents in counties which suffered most, with scarcely an exception have been to the effect that while there was great destitution no cases of starvation occurred. The following are a few of the most gloomy statements:

Severe destitution prevailed, and I think in some cases, perhaps death from disease was hastened from want of proper food.—[J. H. Lay, Warsaw, Benton county.

Cases of actual destitution and starvation positively did occur. A large number of families were compelled to leave our county. They were forced to get out to procure bread for their starving children—among whom were some of our best families.—[A. C. Loveridge, Harrisonville, Cass county.

There was no starvation, but undoubtedly would have been, if assistance had not been given.—[H. L. Hewitt, Austin, Cass county.

There were many cases of partial destitution in this county, but none of actual starvation that I know of.—[Wm. A. Smith, East Lynne, Cass county.

No cases of starvation to my knowledge, but great destitution.—[W. H. Barron, Raymore, Cass county.

None to my knowledge, although some were in straitened circumstances for food and were aided by their more fortunate friends.—[Dan. Carpenter, Barry, Clay county.

There were cases of extreme destitution, but none of starvation.—[D. C. McIntire, Norris Fork P. O., Henry county.

There was destitution but no starving that I know of.—[I. J. Quick, Gaines Farm, Henry county.

No cases of starvation occurred to my knowledge, but many were put on short allowance, and much stock actually perished for want of food.—[Z. S. Ragan, Independence, Jackson county.

To my knowledge, I cannot say that any person starved to death directly, but hundreds and thousands of men and beasts did not get the necessaries to keep them up in vigor and strength, required to do the work allotted to them after the destruction. I knew several to say they put their crops in on bread and water, and the bread gave out and they had to leave for other parts to make a living; and thousands were compelled to mortgage and pledge their property. It was represented by some of the wealthy money mongers that Johnson county could take care of her destitute, which prevented much assistance and aid for distribution from coming here; though considerable was sent and distributed by the society of Dunkards, Granges and other individuals, and this alleviated our situation very much.—[John Zimmerman, Warrensburg township, Johnson county.

Destitution did exist, but probably no positive starvation, in this immediate vicinity.—[Calvin A. Mark, Warrensburg, Johnson county.

No; the good people of St. Louis, and other parts of the State, prevented starvation, and the rich helped the poor everywhere in the county.—[B. F. Dunkley, Dunksburg, Johnson county.

We think not, but many families were upon very short allowance a considerable time, having nothing to eat but poor bread and water.—[J. T. Ferguson, Linabar, Lafayette county.

There were cases of destitution, but aid from abroad, and assistance at home, prevented any cases of starvation.—J. Belt, Napoleon, Lafayette county.

None, to my knowledge, but there must have been much suffering, and even death, but for the praiseworthy response of the citizens of both Lafayette and other counties, as well as the city of St. Louis.—[Jas. E. Gladish, Aullsville, Lafayette county.

There were many cases of actual destitution in this county, but none of starvation.—Jno. L. Modrel, Little Osage, Vernon county.

THE GOVERNOR'S PROCLAMATION.

The general interest awakened in the various endeavors to aid the sufferers was, without doubt, largely due to the active sympathy and the prompt attention given to the subject by Governor Hardin. About the middle of May he issued the following proclamation:

Whereas, owing to the failures and losses of crops much suffering has been endured by many of our people during the past few months, and similar calamities are impending upon larger communities, and may possibly extend to the whole State, and if not abated will eventuate in sore distress and famine;

Wherefore, be it known that the 3d day of June proximo is hereby appointed and set apart as a day of fasting and prayer, that Almighty God may be invoked to remove from our midst those impending calamities, and to grant instead the blessings of abundance and plenty; and the people and all the officers of the State are hereby requested to desist, during that day, from their usual employments, and to assemble at their places of worship for humble and devout prayer, and to otherwise observe the day as one of fasting and prayer.

In testimony whereof, I have hereunto set my hand, and caused the great seal of the State of Missouri to be affixed, in the City of Jefferson, this 17th day of May, 1875.

C. H. HARDIN.

By the Governor:

M. K. McGrath, Secretary of State.

This proclamation naturally drew forth a large amount of comment, and our worthy Governor was ridiculed or praised according as fancy inspired newspaper men. As I was myself taken to task by no less a personage than the Reverend Doctor W. Pope Yeaman of the Third Baptist Church of St. Louis, for supposed ridicule and for taking "unnecessary pains to sneer at Providence," it may be as well to state that the only sentiment I ever expressed, either by word of mouth or by pen, as to the proclamation, is contained in an article published in the St. Louis *Globe* of May 19, where I wrote:

> I deeply and sincerely appreciate the sympathy which our worthy Governor manifests for the suffering people of our western counties, through the proclamation which sets apart the 3d of June as a day of fasting and prayer that the great author of our being may be invoked to remove impending calamities. Yet, without discussing the question as to the efficacy of prayer in affecting the physical world, no one will for a moment doubt that the supplications of the people will more surely be granted if accompanied by well-directed, energetic work. When, in 1853, Lord Palmerston was besought by the Scotch Presbyterians to appoint a day for national fasting, humiliation and prayer, that the cholera might be averted, he suggested that it would be more beneficial to feed the poor, cleanse the cesspools, ventilate the houses and remove the causes and sources of contagion which, if allowed to remain, will infallibly breed pestilence, "in spite of all the prayers and fastings of a united but inactive nation." We are commanded by the best authority to prove our faith by our work. For my part, I would like to see the prayers of the people take on the substantial form of collections, made in the churches throughout the State, for the benefit of the sufferers, and distributed by organized authority; or, what would be still better, the State authorities, if it is in their power, should offer a premium for every bushel of young locusts destroyed. In this way the more destitute of the people in the infested districts would have a strong incentive to destroy the young locusts, and thus avert future injury, and at the same time furnish the means of earning a living until the danger is past. The locusts thus collected and destroyed could be fed to poultry and hogs, buried as manure, or dried, pulverized and sold for the same purpose.

As stated in my reply to Dr. Yeaman, "my intercourse with Governor Hardin has led me to honor him as a Chief Magistrate whom the State will learn to appreciate more and more, and I hold him in too great respect to have much sympathy with the mere flippant ridicule that has been made of the proclamation. Though I may not have overmuch piety and faith myself, I at least know how to respect those qualities in others, and however much I believe that the insect which was the remote cause of Dr. Yeaman's sermon is governed by natural laws, which should guide us in understanding and overcoming it, the reverend gentleman forgets his calling, and makes himself ridiculous, in charging, for such reasons, that I 'sneer at Providence.'"

As the most effective and substantial method of observing the day of fasting and prayer, Gov. Hardin on the 24th of May, wisely issued a second proclamation, urging the benevolent and charitable, who might assemble on the 3d of June in public worship, and felt so disposed, to make contributions and forward the same to Jesse Chilton, Harrisonville, Cass county; R. B. Harwood, Warrensburg, John-

son county; Dr. G. Y. Salmon, Clinton, Henry county; Dr. G. N. V. Dodson, Nevada, Vernon county, and F. G. Tygard, Butler, Bates county, and to the presiding judges of such other counties as are known to need relief.

The third of June was well observed in most parts of the State, and the observance of the day was productive of good not only by the collections taken up in the different churches for the sufferers, but by reassuring and encouraging many good people who could have been reassured in no other way.

NOT A DIVINE VISITATION.

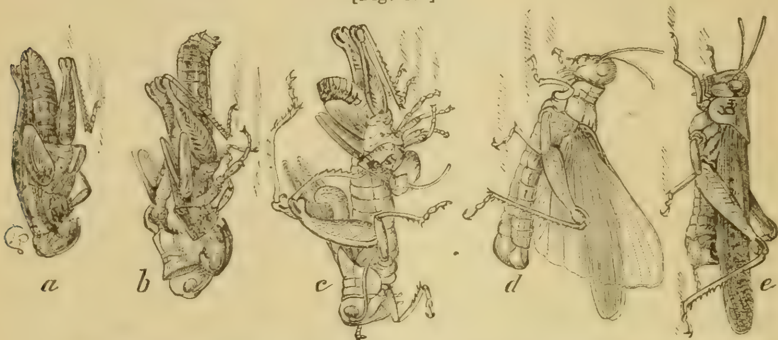
There are those, both among the clergy and the laity, who deem such a visitation as that from which our western counties suffered, an expression of Divine wrath, for the sin and corruption of the people—a chastisement of the Lord. They claim that the "wickedness, fraud, falsehood, and corruption" which, as they assert, "abound in every department of society," are at the bottom of it. They consider it impious to attempt to avert the evil. These opinions were boldly proclaimed by a correspondent of the St. Louis *Republican*. The expression of such opinions was a downright insult to the hard-working, industrious, and suffering farmers of the western country, who certainly deserve no more to be thus visited by Divine wrath than the people of other parts of the State and country. Persons who promulgate such views are little removed in intelligence from the poor crack-brained negress whom I saw in the streets of Warrensburg shouting and imploring the people not to kill a locust, since God Almighty had sent them; or from the poor deluded Arabs who make no effort to destroy the locusts which they believe to be the "army of the Great God." It is not surprising that people are yet found who hold such views; for no great calamity ever befell a country which was not attributed, by certain fanatics, to Divine wrath; but it is surprising that, in this enlightened day, such persons can, without editorial reproof, find circulation for their vagaries in the columns of some of our widely circulating and influential journals.

NATURAL HISTORY.

In addition to what was said under this head a year ago, a more detailed account of the process of molting may here be given. In order to illustrate this interesting process we will trace an individual through the last molt—from the pupa to the winged insect—as it is the most difficult, and, on account of the larger size of the animal, most

easily watched. The other molts are very similar, except that the wing-pads increase but moderately in size with each. When about to acquire wings the pupa crawls up some post, weed, grass-stalk or other object, and clutches such object securely by the hind feet which are drawn up under the body. In doing so the favorite position is with the head downward, though this is by no means essential. Remaining motionless in this position for several hours, with antennæ drawn down over the face, and the whole aspect betokening helplessness, the thorax, especially between the wing-pads, is noticed to swell. Presently the skin along this swollen portion splits right along the

[Fig. 39.]



Rocky Mountain Locust :—Process of acquiring wings ; *a*, pupa with skin just split on the back ; *b*, the imago extruding; *c*, do. nearly out; *d*, do. with wings expanded; *c*, do. with all parts perfect.

middle of the head and thorax, starting by a transverse curved suture between the eyes, and ending at the base of the abdomen. Let us now imagine that we are watching one from the moment of this splitting, and when it presents the appearance of Fig. 39, *a*. As soon as the skin is split, the soft and white fore-body and head swell and gradually extrude more and more by a series of muscular contortions; the new head slowly emerges from the old skin which, with its empty eyes, is worked back beneath; the new feelers and legs are being drawn from their casings, and the future wings from their sheaths. At the end of six or seven minutes our locust—no longer pupa and not yet imago—looks as in my Fig. 39, *b*, the four front pupa-legs being generally detached and the insect hanging by the hooks of the hind feet, which were anchored while yet it had that command over them which it has now lost. The receding skin is transparent and loosened, especially from the extremities. In six or seven minutes more of arduous labor—of swelling and contracting—with an occasional brief respite, the antennæ and the four front legs are freed, and the fulled and crimped wings extricated. The soft front legs rapidly stiffen and, holding to its support as well as may be with these, the nascent locust

employs whatever muscular force it is capable of to draw out the end of the abdomen and its long hind legs (Fig. 39, *c*). This in a few more minutes it finally does, and with gait as unsteady as that of a new-dropped colt, it turns round and clambers up by the side of the shrunken cast-off skin, and there rests while the wings expand and every part of the body hardens and gains strength—the crooked limbs straightening and the wings unfolding and expanding like the petals of some pale flower. The front wings are at first rolled longitudinally to a point, and as they expand and unroll, the hind wings which are tucked and gathered along the veins, at first curl over them. In ten or fifteen minutes from the time of extrication these wings are fully expanded and hang down like dampened rags (Fig. 39, *d*). From this point on, the broad hind wings begin to fold up like fans beneath the narrower front ones, and in another ten minutes they have assumed the normal attitude of rest. Meanwhile the pale colors which always belong to the insect while molting have been gradually giving way to the natural tints, and at this stage our new-fledged locust presents an aspect fresh and bright (Fig. 39, *e*). If now we examine the cast-off skin we shall find every part entire with the exception of the rupture which originally took place on the back; and it would puzzle one who had not witnessed the operation to divine how the now stiff hind shanks of the mature insect had been extricated from the bent skeleton left behind. They are in fact drawn over the bent knee joint, so that during the process they have been bent double throughout their length. They were as supple at the time as an oil-soaked string, and for some time after extrication they show the effects of this severe bending by their curved appearance.

The molting, from the bursting of the pupa skin to the full adjustment of the wings and straightening of the legs of the perfect insect, occupies less than three-quarters of an hour and sometimes but half an hour. It takes place most frequently during the warmer hours of the morning, and within an hour after the wings are once in position the parts have become sufficiently dry and stiffened to enable the insect to move about with ease, and in another hour, with appetite sharpened by long fast, it joins its voracious comrades and tries its new jaws. The molting period, especially the last, is a very critical one, and during the helplessness that belongs to it the unfortunate locust falls a prey to many enemies which otherwise would not molest it, and not unfrequently to the voracity of the more active individuals of its own species.

As stated a year ago (Rep. 7, p. 123) there are four molts exclusive of that which takes place upon leaving the egg. In the first

stage—that following the egg—the wing-pads are not visible; in the second (after the first molt) they project but little beyond the meso and metathorax, differ but little in size, and are directed downwards, lying separately close to the body: in the third stage (after second molt) they are directed upward, the hind covering and hiding more or less the front pair, and the joints bearing them retreating more beneath the prothorax: in the fourth stage (after third molt) they are enlarged as seen in the pupa, and with the fourth molt the fifth or perfect stage is attained. European authors differ as to whether there are three, four or five molts in the European migratory species;* but I have watched *spretus* from the egg to the imago, and thousands of mounted and alcoholic specimens of all ages, show distinctly the five stages enumerated, and these only.

HABITS OF THE UNFLEDGED LOCUSTS.

Never having had before the opportunity of observing the habits of the young insects as they hatch out in the Mississippi Valley, the experience of last Spring was very interesting to me, as well as valuable. As I had stated they would, the great bulk of these young hatched out about the middle of April, but others kept on hatching even up to the time when the first hatched got wings, so that up to the 1st of June they were met with of all sizes from the newly hatched to the winged. So long as provision sufficed for them on their hatching grounds they remained almost stationary, and created but little general apprehension, although many farms on bottom lands and fields adjacent to timber were overrun with them. As soon, however, as the supply of food in these situations was exhausted, they commenced to migrate, frequently in bodies a mile wide, devouring as they advanced all the grass, grain and garden truck in their path. The migrating propensity was in no instance, that came to my knowledge, developed till after the first molt. Up to that time they were content to huddle in warm places, and lived for the most part on weeds, and especially on the common dog fennel or mayweed (*Maruta*.)

The young locusts display gregarious instincts from the start, and congregate in immense numbers in warm and sunny places. They thus often blacken the sides of houses or the sides of hills—the prevailing tint of the mass during the first and second larval stages being a dull, deep gray. They remain thus huddled together during cold, damp weather. When not traveling, and when food is abundant, or during bad, rainy weather, they are fond of congregating on fences, buildings, trees, or anything removed from the moist ground. They

* See Köppen, "Ueber die Heuschrecken in Suedrussland," 1866, pp. 22-3.

also prefer to get into such positions to undergo their different molts.

Their power for injury increases with their growth. At first devouring the vegetation in particular fields and patches in the vicinity of their birth-places, they gradually widen the area of their devastation, until at last they devour every green thing over extensive districts. Whenever they have thus devastated a country they are forced to feed upon one another, and perish in immense numbers from debility and starvation. Whenever timber is accessible they collect in it, and after cleaning out the underbrush, feed upon the dead leaves and bark. A few succeed in climbing up into the rougher-barked trees, where they feed upon the foliage, and it is amusing to see with what avidity the famished individuals below scramble for any fallen leaf that the more fortunate mounted ones may chance to sever. This increase in destructiveness continues until the bulk of the locusts have undergone their larval molts and attained the *pupa* state. The *pupa*, being brighter colored, with more orange than the larva, the insects now look, as they congregate, like swarms of bees. From this time on they begin to decrease in numbers, though retaining their ravenous propensities. They die rapidly from disease and from the attacks of natural enemies, while a large number fall a prey, while in the helpless condition of molting, to the cannibalistic proclivities of their own kind. Those that acquire wings rise in the air during the warmer parts of the day and wend their way as far as the wind will permit toward their native home in the northwest. They mostly carry with them the germs of disease or are parasitized, and wherever they settle do comparatively little damage.

DIRECTIONS IN WHICH THE YOUNG LOCUSTS TRAVEL.

The young insects move, as a rule, during the warmer hours of the day only, feeding, if hungry, by the way, but generally marching in a given direction until toward evening. They travel in schools or armies, in no particular direction, but purely in search of food—the same school often pursuing a different course one day to that pursued the day previous. On this point the experience of last Spring is conclusive; and while the bulk of the testimony as to their actions, when hatching out in States further north and west, is to the effect that the prevailing direction taken is south or southeast, the *prevailing* direction taken last Spring, in Missouri, as gathered from the reports of numerous correspondents, was northward, sometimes a little to the east, at others to the west. I have, while traveling along a road, often seen them marching in one direction to the left and in the opposite direction to the right of me. They were more often noticed

going against than with the wind, and, as they approached maturity, they seemed disposed to gather into more compact masses and prefer to advance in a northerly direction. The following extracts are given as illustrative of the experience of my correspondents:

There was no particular direction pursued by them; they went to one point of the compass as much as another, but when they moved, large bodies went in one direction. They traveled in columns from 4 to 40 rods wide, and fences and other obstacles frequently caused them to vary their course. The front of a column coming to an obstacle at right angles, (such as a fence or building) usually went through or over. But I have seen a column going southeast and another going southwest, come to an east and west fence, and then take their course along it in opposite directions, jumping over or against one another in an amusing manner. I opened the fence and set a wide plank on edge in the gap, that guided them through, and then from there they all took one direction south, many bushels passed through in a few hours.—[CALVIN A. MARK, Warrensburg, Johnson county.

They moved while yet unfledged in all directions, that is, different droves moved in different directions, and so persistent were they in their course, that they were seen to cross at right angles without becoming confused.—[G. W. ALLEN, Westport, Jackson county.

Although they move in nearly every direction at times, yet the whole movement was north.—[DAN. CARPENTER, Barry, Clay county.

There was no particular direction noticed, but they seemed to go against the wind to a great extent, but not always.—[J. W. MAPLE, Oregon, Holt county.

They were inclined to travel in a northwest direction, though they would go some little distance in other directions to get wheat and other things which they liked to eat. —[LEVI LONG, Island City, Gentry Co.

In this locality they traveled when unfledged, east and southeast. Living on the east of the Potawatomie creek, the young locusts which were hatched out near the timber had to travel in this direction to find food. On the west side of the creek they traveled west or northwest, for the same reason. On one occasion they were seen crossing each others track, traveling in different directions.—[JAMES HANWAY, Lane, Franklin Co., Kansas.

RATE AT WHICH THE YOUNG TRAVEL.

Having often watched the young insects on their travels and carefully timed them, I have concluded that when about half grown they seldom move at a greater rate than three yards a minute, even when at their greatest speed over a tolerably smooth and level road, and not halting to feed. They walk three-fourths this distance and hop the rest. Two consecutive hops are seldom taken, and any individual one may be run down and fatigued by obliging it to hop ten or twelve times without rest.

THEY REACHED BUT A FEW MILES EAST OF WHERE THEY HATCHED.

Rumors prevailed continually last Spring that the insects were spreading eastward and threatened to overrun the whole of the State, Illinois, etc. In reality, as I continually urged would be the case, they did not reach on an average five miles east of the limit line where they hatched. The reason is plain enough. At the rate at which they travel, as just described, they could not extend many

miles, even if they continued to travel in one direction from the time of hatching till maturity. They travel only during the hotter portions of the day, say six hours on an average; and their unfledged existence terminates in from six to eight, say seven weeks. It is very easy to calculate from these facts that if they continued in one direction from the time they hatch until they acquire wings, they would not extend thirty miles. In reality, however, they do not travel every day, and where food is abundant they scarcely travel at all. Moreover, as just shown, they do not commence traveling till after the first molt, and they do not go continually in a particularly eastern direction, but in all directions.

We have already seen that the winged insects took a northwest direction, and none flew to the east. Yet a few stragglers were carried as far as the centre of the State by being swept into the Missouri and drifted on logs and chips during the annual rise of that river in July; for I received specimens of the genuine *spretus* thus brought as far as Rocheport in Boone county, from Mr. Robert A. Caskie of that place.

NOT LED BY "KINGS" OR "QUEENS."

The idea that the young hoppers were led in their marches by so-called "kings" or "queens" was very prevalent last Spring. It is, however, quite unfounded. Certain large locusts belonging to the genera *Acridium* and *Œdipoda* hibernate in the full grown, winged

[Fig. 40.]

AMERICAN ACRIDIUM.

state, and not in the egg state, like the Rocky Mountain species. Always with us, their presence was simply more manifest last Spring, when the face of the earth was bare. Hopping with the others or falling into ditches with them, they gave rise to this false notion, and it is an interesting fact as showing how the same circumstances at times give rise to similar erroneous ideas in widely separate parts of the world, that the same idea prevails in parts of Europe and Asia.

The two species which are most often thus found with the young locusts and supposed from their size and conspicuity to be guides, are

the American Acridium (*Acridium Americanum*, Drury, Fig. 40), and the Coral-winged Locust (*Œdipoda phœnicoptera* Germ., Fig. 41). The former is our largest and most elegant locust, the prevailing color being dark brown, with a broad, pale yellowish line along the middle of the back when the wings are closed. The rest of the body is marked with deep brown, verging to black, with pale reddish-brown, and with whitish, or greenish-yellow; the front wings being prettily mottled, the hind wings very faintly greenish with brown veins, and the hind shanks generally coral-red with black-tipped, white spines. The species is quite variable in color, size and marks, and several of the varieties have been described as distinct species. The Coral-winged Locust is also an elegant species, the colors being brown-black, brick-yellow inclining to brown, and a still paler, whitish-gray; the hind wings varying from vermillion-red to pink, with more or less yellowish-green, and with a broad external dusky border, broadest and palest at tip. The hind shanks are yellow with black-tipped spines. This species is also quite variable, and at least half a dozen of its slight variations have been seized upon to fabricate new species.

[Fig. 41.]

CORAL-WINGED LOCUST.

THE EXODUS IN 1875.

The grand exodus of the flying swarms from our borders began early in June, and reached its acme about the middle of the month. Some were leaving up to the last week in the month. The cheering news "they fly, they fly," was wired over the country from Coffeyville, Kansas, on the 29th of May, and a few days later these same words that cheered the waning spirit of General Wolfe as he saw that victory remained with England, and Canada was lost to France, passed along the lines from our Western counties, and gladdened the hearts and revived the dying hopes of the suffering farmers.

TIME OF LEAVING OF THE WINGED INSECTS.

The insects which hatched in Northern Texas and Indian Territory, began to leave on wing in greatest numbers, during the second and third weeks of May, and they doubtless went to make up the swarms which were reported as flying at intervals over Western Kansas and Nebraska, during the last half of that month. The grand hegira began, however, during the last two or three days of the month from Southern Kansas, where the insects were more numerous than farther south. By

the 15th of June, they had nearly all left from as far north as Leavenworth. From the 7th of June on throughout the month, they were flying over Southwest Iowa and Nebraska, being most numerous, judging from the balance of the many reports collected, about the middle of the month. A little later the bulk of them was flying over Dakota, and they are reported as flying most numerously in Montana during the month of July. The following memoranda from two of my correspondents, show how almost continuously during the first three weeks in June, they were observed passing over the northwestern portion of our own State:

From my diary, I find that they commenced rising up and leaving for the first time on the 31st day of May; flight, northwest. June 1st, course north. June 2d, northeast at noon; at 3 P. M., course west; 3d, northeast; 4th, rain prevented any from leaving; 5th, cloudy, none flying; 6th, flying northeast at noon; at 3 P. M., course west. June 7th, noon to 1 P. M., southwest; 3 P. M., flying west, with wind from northwest, and seemed confused; and while they could not stem the current of wind to make their desired course, they were shifting to new quarters in search of food. June 8th, leaving in large numbers, course northeast. June 9th, heavy rain the past night—hoppers doing heavy damage to our orchards; noon to 1 P. M., flying confusedly, but generally bearing to the northeast. June 10th, attempting to fly northeast, but heavy winds will not admit of their leaving. June 11th, flying northeast, nearly east. June 12th, flying west upper current, but an under-current of wind caused multiplied millions to come down, covering the whole face of the earth. June 13th, 9 o'clock A. M, commenced flying northwest till 11, when the wind shifted to the northeast, great numbers came down, and did great damage to our trees. June 14th, flight northeast. June 15th, but few leaving. June 16th, course northeast. June 17th, flying north in vast numbers. June 18th, cloudy; but few flying. June 19th, flight northeast; immense swarms of them. June 20th, flight northeast, in vast numbers. June 21st, hoppers thinning out; a few flying at 1 P. M. June 22d, flying in considerable numbers to the northeast. June 23d, flying but little, and we commenced replanting our corn and garden.—[Z. S. RAGAN, Independence, Jackson Co.

To give you some idea of the locust plague, let me describe briefly their flight. Eleven days ago they began to pass here overhead. They begin to rise up about 9 o'clock, and by 10 o'clock they are nearly all on the wing. They go as the wind drives them. Excepting one day, when we had a wind from the north, their flight has been from the south northerly. Looking up, at any time between the hours of 10 and 4, towards the sun, they may be seen passing like large snow flakes, rapidly as their wings and the wind can make them. By a large spy-glass I judge the swarm to be about half a mile deep. And so they go, day after day. By night they settle down. On the evening of the day before yesterday, we concluded the swarms were about exhausted, as not nearly so many had passed during that afternoon, and we congratulated ourselves on possible future exemption. But yesterday the air was again full of them; and last evening about six miles north of this, they came down in a line extending all across the country in such tremendous clouds as to frighten people. Many persons that were out ran in-doors, fearing lest they might be smothered. A gentleman, Judge Russell, who was riding along, said that for some time he regarded it as a vast storm-cloud coming down over the whole land, and the sound was said by one to resemble that made by a locomotive and long train of cars. Now, to-day, with a southeast wind, the air is again filled with them, flying to the northwest.—[CLARKE IRVINE, Oregon, Holt Co., June 18.

DIRECTION TAKEN BY THE WINGED INSECTS.

From the facts recorded in considering the last Spring's history of the plague by States, and particularly by the observations so kindly obtained for me from the Territories by General Myer, Chief of the Signal Bureau, it is evident that the main direction taken by the insects that rose from the lower Missouri Valley country was northwesterly: in

other words, toward what I believe to be the native home of the species, whence their parents had come in 1874. That they instinctively sought this direction there can, I think, be no doubt; for while they depend in great part on the wind for propulsion, and without its aid would be unable to migrate to very great distances, I have a large number of reports to show that whenever the wind blew from the north or northwest, the locusts came down and waited a change to a more favorable direction. They begin to rise when the dew has evaporated, and descend again toward evening. A swarm passing over a country yet infested with the mature insects, constantly receives accretions from these, and is, consequently, always more dense in the afternoon than in the forenoon. In rising, the insects generally face the wind, and it is doubtful if they could ascend to any great height without doing so. They are, I believe, good navigators, and know how to take advantage of the different air currents. The rate at which they travel will depend on the force of the wind; but it is evident from the observations made in Dakota, where their advance was reported by telegraph, (*ante* p. 37,) that last Spring they often traveled a hundred miles a day. Their minimum speed, in tolerably calm weather, when the wind is scarcely felt at the surface of the ground cannot be much less than from eight to ten miles an hour.

The exceptions to the northwest course occurred toward the end of the first week in July, when swarms were seen flying southeast over northeastern Kansas. These could hardly have originated in the adjacent parts of Iowa or Missouri, as the bulk of the insects had by that time left that section; they were probably detachments of the swarms that left Minnesota about the first of the month and which, as their parents came from the southeast in 1874, instinctively flew in that direction. During July they also flew south from their native hatching grounds in Colorado; while later in the season, viz. in August, fresh swarms from the northwest and west flew over that State in a southeast direction.

DESTINATION OF THE DEPARTING SWARMS.

That the swarms which left the fertile country in which they hatched and are not indigenous—say all the infested region lying south of the 44th parallel and east of the 100th meridian—passed by degrees to the northwest and reached into northwest Dakota, Wyoming and Montana, the records clearly prove. Whether or not they reached up into British America, I have no means of judging. I believe, however, that few, if any, did. Those which survived long enough to deposit eggs evidently reached the higher and treeless

regions north and west of the region just indicated; but that a large proportion of those which took wing perished on the way from debility, the effects of storms, and more particularly the attacks of parasites, there can be little doubt; because I proved by careful dissection that a large proportion of those which came to maturity and left our own western counties, carried with them the germs of destruction in the shape of *Tachina* eggs or the larvæ already hatched and of various sizes. Others again were infested with the scarlet mites. As some persons have expressed doubts as to whether these locusts are ever killed by the parasites I described last year, I will state that before the insects began to leave Missouri last Spring large numbers had actually died of these parasites, and that on five different occasions in five different localities, a hundred of the winged specimens taken at random showed 5, 8, 10, 23 and 52 per cent. infested with Tachina larvæ alone, to say nothing of mites. The following items in addition to what is recorded on preceding pages, will show how very generally over the country vacated by the locusts, this parasitism occurred:

FORT SCOTT, Kas., June 1.—Messrs. Durkee and Stout, extensive and successful farmers near this city, report that they have caught in a sheet and killed some six or seven bushels of grasshoppers or Rocky Mountain locusts. They have examined large numbers of them by dissection and close inspection, and find that about nine out of every twelve so examined contain a well developed maggot, alive, and differing in size and development. These they feel sure after a thorough examination, will eventually kill and exterminate the entire grasshopper tribe in this country in a very short time. In proof of the existence of this maggot found inside, Messrs Durkee and Stout state that the large piles of grasshoppers which they have killed are almost immediately alive with the maggots.

Mr. Young, another large farmer, reports to-day that they are leaving in the last few days, flying away high in the air in large numbers. All of these, however, it is thought, contain the parasite or maggot above spoken of, and will never be able to do any further damage. It is thought that the season of the year has come when we can anticipate no further damage, and we do not any more in this section.—[From a dispatch to the Kansas City *Times*.

The general Government should appoint a Commission to study the habits of the locusts, ascertaining where they come from, and where they have gone, and obtain full information concerning them. It is known that all leaving this country were covered with parasites, and it is believed that these parasites destroy them, but there is a very general feeling that too little is known of the pests, and it is the duty of the Government to appoint a competent Commission for the study of their habits. Senator Ingalls has telegraphed to the Secretary of War, asking him to direct military and signal officers throughout the Northwest to observe and report their movements.—[Correspondence to the Chicago *Tribune*, from Atchison, Kans , June 16.

It is reported that some kind of insect has destroyed the grasshoppers in Bourbon county, as they lay dead in heaps on the roadside. It is said they are dying everywhere in the southern part of the State. A farmer from Jefferson county says that some kind of an insect or parasite is destroying them by the thousands in his locality. Another farmer reports the same in his locality ; and that handsful of dead grasshoppers can be gathered. We are having continued rain-falls, and it is said the wet weather is favorable to the destruction of these pests. A gentleman, just returned from a tour through Jackson, Cass and Bates counties, Missouri, says the grasshoppers are much more numerous in that section than in this.—[Chicago *Tribune* correspondence from Atchison, Kans., May 18.

Reports from the grasshopper districts Friday are more encouraging. They are leaving as fast as they get wings, and parasites are making sad havoc in their ranks. When a column of them take flight many are observed to fall to the ground unable to fly. An examination invariably shows that they have been so enfeebled by maggots that they are unable to get away and soon die.—[Jefferson City *Tribune*, June 9.

There are a few people who yet refuse to believe that parasites are destroying the locusts. Hundreds of the most intelligent and practical men in the State have carefully studied this question, and all agree, so far as we have heard, that not one locust in a thousand will live long enough to reach his native country in the northwest. Ninety-nine out of every hundred of these pests are covered with parasites. We recently examined a grasshopper with a powerful microscope, and counted twenty-four parasites upon it. Upon nearly every hopper that can be found will be found from two to a dozen of these parasites, ranging in size from a minute atom, hardly visible to the naked eye, to the proportions of a pin-head.

Experienced entomologists, and careful, observant, practical men of all classes, have devoted great attention to the study of these parasites. And their investigations conclusively prove that, so far as the grasshoppers visiting this region are concerned, their race is run. They are dying by millions. Those that live to get back to their native haunts cannot propagate their species. Nature, always faithful in adjusting its balances, has provided an enemy capable of mastering the grasshopper, and this enemy is the little red parasite that can be found either on his wings or his body.—[Atchison (Kans.) *Champion*; forepart of June.

Thousands of grasshoppers fell to the ground in the Republican Valley and elsewhere, while flying, and all seemed to be destroyed by parasites, eating into the body at the base of the wings. Within the last few days I have examined many localities in the vicinity of Lincoln, where the grasshoppers have appeared, and in five spots found the ground covered with their dead bodies, which, on examination with the microscope, were seen to be literally devoured by these minute parasites. I hear the same thing reported from different parts of the State. — [Correspondence of the Lincoln (Nebr.) *Journal*, about the middle of June.

Mr. Al. Dunbar brought to our office this morning a handful of healthy looking locusts, and requested us to inspect them. We did so, and pronounced them a fair article. He then dissected them, one by one—by pulling them apart just below the head — and in the upper part of the body of six out of eight locusts, a white worm about one fourth of an inch long, was discovered. The balance might have been infested also, but not having a microscope we could not tell. Other persons have discovered these worms, and report that the locusts are dying rapidly. The worms are hatched from an egg deposited beneath the leg or wing by an insect similar to a common house-fly.—[Warrensburg (Mo) *News*, June 2.

From this experience we may very justly conclude that a large proportion of the insects which departed from the country invaded in 1874, perished on their way toward the native habitat of the species, and that those which did not so perish reached the Rocky Mountain region of the northwest whence their parents had come the previous year. They struggled back with thinned and weakened ranks, and it will probably take many years ere they become so prodigiously multiplied again, and are enabled by favorable conditions to push so far east as they did in the year 1874. They did some harm at their resting places on the way, but in a large number of instances, they rose after their brief halts, without doing serious injury. Nor can I learn of any instances where these swarms that left our territory deposited eggs. Had the winds been adverse to their northwestern course, and obliged them to remain in the country where they hatched, I believe that the bulk, if not all of them, would nevertheless have perished before laying eggs.

NATIVE HOME OF THE SPECIES.

The question as to the native home of the species will always interest. Having carefully weighed all that has been written on the subject during the year, and eagerly sought all information that might shed light upon it, I am firmly convinced of the general truth of the views enunciated under this head in my last Report. The species is, in fact, "at home in the higher altitudes of Utah, Idaho, Colorado, Wyoming, Montana, northwest Dakota and British America. It breeds in all this region, but particularly on the vast hot and dry plains and plateaus of the last named Territories, and on the plains west of the Mountains." In that country alone does it come to perfection for a series of years, and in that country alone can it become so prodigiously multiplied, and be borne by the wind to such distances as to overrun the country already indicated (p. 106) where it is not indigenous, and reach as far east as it did in 1874. To this end, also, a combination of favorable conditions that only occasionally occur, are necessary. The best evidence of the soundness of a theory is its power of absorbing newly ascertained facts and of overcoming objections that are raised against it. The facts already adduced as to the direction and destination of the departing swarms from the lower Missouri and Arkansas river country add strength to the theory. I will here briefly notice the principal objections to it, made by Mr. S. H. Scudder, as a means of adding to the arguments already brought forward. In the Proceedings of the Cambridge Entomological Club for June 11, 1875, as reported in *Psyche* (the organ of the club), for Febr. 1876 (Vol. 1, p. 144) occurs the following:

Mr. Scudder offered some remarks on Mr. Riley's account of *Caloptenus spretus* in his recent Annual Report. The speaker doubted whether these insects took flight from the heart of the Rocky Mountains [1] to the localities in which they were destructive, passing over the wide expanse of arid plains which intervene, because there has been no record of their occurrence in swarms in these plains, and there is sufficient ground for the supposition that they may have developed in the immediate vicinity of the regions which they devastate [2]. It is well known that among other insects there are years in which individuals are suddenly very abundant, and intervening series of years in which few are to be found. It is also known that a few of these locusts can be found in Kansas and Missouri, and in fact from Texas to Manitoba every year, [3] so it seems hardly necessary to look so far for the derivation of the destructive swarms. Moreover, the circumstance, mentioned by Mr. Riley, that the locusts get tired after repeated flights, is an additional argument against the supposition that they came from a great distance, for the rate at which their strength diminished seemed out of all proportion to the activity of the insects at the time of their first ravages. [4.]

[1] I have nowhere spoken of the "heart of the Rocky Mountains" as the source of the swarms that take their flight to our country. On the contrary, my language is very different (*vide* Rep. 7, p. 163), and it is upon this kind of misapprehension that Mr. Scudder's remarks are based.

[2] It is difficult to comprehend what is meant here, since I have myself shown that much of the country devastated must be in the immediate vicinity of the hot, dry plains and plateaus in which I believe the species is more particularly at home. I have also expressed my belief that the swarms that occasionally, during Summer, devastate the country in which the species is not indigenous, must necessarily be the progeny of insects developed at no great distance from the sections they invade, whether they come from Minnesota southward; from Colorado eastward, or from Texas northward; and I endeavored to draw the distinction in 1874 between these Summer swarms and the more disastrous Falls warms. On this point the Minnesota Commission remarks (Special Rep. to Gov. Davis, p. 25):

> It is plain that locusts hatched in Colorado and regions to the south and southwest of Minnesota acquire wings in time to allow them to reach this State in the former half of June. This is shown by the time when the invasion occurred in 1873, and by the immense flights of locusts which passed over Nebraska and Dakota to the northward in June, 1875. It seems to be a common impression that the locusts which have invaded Minnesota at other times were hatched in Montana, northwestern Dakota and British America, and this is rendered probable by what few facts we know, and by the time and direction from which they came. These attacks are all represented as coming from the west, north or northwest, and reached the Red River Settlement in the last week of July, 1818, the Upper Mississippi about the same time in 1856, the western line of the State in the former half of July, 1864, and on July 15th, 1874. In the last three cases the invasions did not reach their farthest limit until a considerable portion of the crops had been harvested.

If Mr. Scudder means that the hordes that occasionally overrun in August and September the whole territory which I have indicated as outside the insect's natural habitat, originate within or upon the borders of that Territory—the country south of the 44th parallel and east of the 100th meridian—then the facts are entirely against his supposition. The late swarms of 1874 are known to have traveled from five to six hundred miles after having reached the more thickly settled country and been observed. The period that elapses between the acquiring of wings and the deposition of eggs is not positively known. From analogy and from a general survey of the facts at hand, I have placed it at from two to three weeks. The Minnesota Commission, in their Special Report to Governor Davis, state (p. 26) that it has been known to be as short as eight days. I think we may safely say, judging from the insects that have hatched out and laid in the same regions in Minnesota, that it will be within a month. Now, the late deposition of eggs—as in September and October, in the region that suffered so last Spring—implies late hatching and development of the parents; and the insects that laid in our western counties, in 1874, must have hatched as late as June 1st, and this late hatching could only occur in the higher sub-alpine regions of the northwest. Of course, in speaking of the hatching of the species, I

do not forget its irregularity in the same locality, and refer in consequence to the bulk of the eggs. The invasion of northern regions, like Minnesota and Dakota, from the still further northwest, makes it also clear that the insects come from beyond. The theory of short flights and development, in the immediate vicinity of the country devastated, will scarcely answer for the late disastrous and general irruptions like those of 1866 and 1874; and in discussing this question the difference between these irruptions and the earlier, more frequent and less disastrous ones, should always be borne in mind.

[3] I deny that the species, as defined in these reports, and as it swoops down from the mountain region, occurs every year in Missouri, Texas, Kansas, or any of the country to which I have indicated it is not indigenous. It occurs there only as the dwindling progeny of the swarms from the west or northwest, and never becomes acclimated. I have traveled through Iowa, and from Omaha to Denver, collecting plants and capturing insects along the route on every occasion; I have traveled extensively in Kansas, Indian Territory and Texas, always collecting; I have been overwhelmed in the latter State with swarms of locusts while in front of an engine, and yet, among all the locusts collected, I have never found the genuine *spretus*. It cannot be found there any more than it can be found in our western counties, except as the progeny of invading swarms. There is no instance on record of the species, when hatching out in any of this country, remaining long enough to lay eggs, even supposing it capable of doing so under such circumstances. We find it multiplying continuously west and north of the boundary indicated; pushing annually, in detachments, eastward from the mountains to the west, and southeastward from the country to the northwest; but only at long intervals does it sweep down in countless myriads and extended and devastating swarms from the extreme northwest. Just beyond the confines of the country in which it permanently multiplies, it follows that it will more often do injury than farther east and south; it will also hold its own longer, but sooner or later it vanishes from the country beyond those confines. It either vacates the territory on the wing or is destroyed by influences adverse to its well-being.

In placing these confines along the 44th parallel and 100th meridian, I think I have given the utmost southern and eastern limit. Prof. Thomas indicates the eastern boundary as along the 103rd meridian, while Mr. G. M. Dawson, in the pamphlet already referred to, says that "north of the 49th parallel, the whole area of the third or highest prairie-plateau, and probably much of the second, are congenial breeding places, and here the locusts are always in greater or less

numbers." Regarding the western boundary, nothing struck Prof. Thomas* as more singular than the few specimens of *spretus* collected west of the mountain range by the Hayden Geological Survey, from which he infers that the line of the survey was along the southwest border of its district. Mr. J. D. Putnam, of Davenport, Iowa, who spent July, August and September of last Summer in Utah, also informs me that he did not meet with a single specimen.

This whole subject of the original source of the swarms that at times lay our fertile valley country under such severe contribution is yet somewhat obscure, and should be investigated by the Government. Meanwhile we must shape our views by the facts in our possession.

[4.] Now that we know where the bulk of the eggs were laid, it seems more than likely that the principal reason of the retarded progress of the 1874 swarms, by the time they reached east Kansas and Missouri was due to the fact that they were more busily engaged in ovipositing than they had previously been. Moreover they there strike a country more or less timbered, with moister atmosphere, and less violent and more changeable winds.

CONDITIONS OF MIGRATION.

The exodus from the country where the species is not indigenous would seem to be instinctive and determined perhaps by the injurious effects of the uncongenial climate. The cause of the migrations from its native northwest home I discussed in my last Report (p. 164). Hunger and strong winds are the principal; but the conditions which permit extended flights and migrations southeast are doubtless, in great part, meteorological, and as throwing light on these conditions, the following from an interesting review of the locust question by Mr. W. H. Miller, and published in the Kansas City *Journal of Commerce*, will prove suggestive:

> Since it has been well ascertained that dry weather is a necessity to its prosperous existence, it is concluded that dry seasons are necessary to its invasions. There is much force in this conclusion, for since the moisture of the western States and Territories is borne to them from the Gulf of Mexico by southerly winds, a dry season indicates a diminishing of these winds, which removes two important impediments in its advance —moisture and opposing currents of air. It is also held by entomologists that it migrates only when the vegetation of its habitat becomes exhausted. A diminished southerly wind, and a dry season on our western plains, would favor this result, for since the moisture of this region comes from the Gulf, a dry season on the plains and short vegetation there would indicate a dry season and short vegetation in the latitude where we have supposed its habitat to be.

* Preface to his Report upon the Collections of Orthoptera made in Nevada, Utah, California, Colorado, New Mexico, and Arizona, in 1871, 1872, 1873 and 1874, by Hayden's Geol. Surv. of the Terr. (1876).

THE CONDITIONS WHICH PREVENT THE PERMANENT SETTLEMENT OF THE SPECIES IN MISSOURI.

The conditions which determine the geographical limits in which a species can exist, are often complex, and it is not generally easy to say precisely what they are. Assuming that I have correctly placed the native home of the species in the higher, treeless and uninhabitable plains of the Rocky Mountain region of the northwest, and that it is sub-alpine, we may perhaps find, in addition to the comparatively sudden change from an attenuated and dry to a more dense and humid atmosphere, another tangible barrier to its permanent multiplication in the more fertile country to the southeast, in the lengthened Summer season. As with annual plants, so with insects (like this locust) which produce but one generation annually and whose active existence is bounded by the Spring and Autumn frosts—the duration of active life is proportioned to the length of the growing season. Hatching late and developing quickly in its native haunts, our Rocky Mountain Locust when born within our borders (and the same will apply in degree to all the country where it is not autochtonous), is in the condition of an annual northern plant sown in more southern climes; and just as this, attains precocious maturity and deteriorates for want of Autumn's ripening influences, so our locust must deteriorate under such circumstances. If those which acquired wings in Missouri early last June had staid with us long enough to lay eggs, even supposing them capable of doing so, these eggs would have inevitably hatched prematurely and the progeny must in consequence have perished.

Being a firm believer in change by modification in what we call species, and that climatic conditions play a most important part in causing this change, and that they act more rapidly than most evolutionists grant, the idea has been very strong in my mind that the species might become profoundly modified in the direction of *Atlanis* in the course of two or three generations in the country to the southeast, and that in this way and through miscegenation with our native species, its extinction from our territory might also be accounted for. It has also been suggested by Prof. Thomas—a professed anti-Darwinian —in an elaborate paper published last October in the Chicago *Inter-Ocean*, and, as bearing on this point, I will state that the specimens which hatched in and left our western counties last Spring were, on an average, somewhat darker and smaller than their parents. But after fully digesting all the facts, I am convinced that these influences play a very unimportant part, if any; and that they cannot be considered as factors in the problem. All that could get away from the

regions of Missouri, Kansas, Iowa and Nebraska ravaged last Spring, did so; and if I may judge from experience in our own State, those that could not, perished, so that not a remnant of the army was left in the Fall.

But whatever the causes, the fact of debility, disease and deterioration in, as well as migration from, the more fertile southeastern country the species occasionally devastates, stands forth clearly and cannot be gainsaid. The following observations from careful observers may be placed on record here:

Mr. Riley is of the opinion that the grasshoppers run out in a few generations after they leave their native sandy and gravelly soil My experiments so far as they go, verify that opinion. For several years I have caught grasshoppers during early summer that came fresh from the direction of the mountains, and by attaching their legs with fine silk threads to a small spring balance, found that their physical strength was from twenty-five to fifty per cent. greater than that of grasshoppers treated the same way that were hatched in Nebraska or in States further eastward or northward. The same result was reached by caging them, and ascertaining how long they would live without food, and also by vivisection. In some places, also, the eggs that were laid in different years since 1864 did not hatch out. The changes from extreme wet to dry, and from cold to hot weather, or some other unknown causes, seems to sap their constitutional vigor. Were it not for this, long ere now these grasshoppers would, from their enormous numbers, have desolated the whole country as far east as the Atlantic. --[Prof. Samuel Aughey, of the University of Nebraska, in the Lincoln (Nebr.) *Journal*.

I have observed hundreds of winged locusts fall to the ground during flight, either already dead or soon dying. These upon examination have generally proved to contain no parasites, and I judge that their death was in consequence of impaired strength, this second generation raised in an unnatural climate not equalling in vitality the first generation and succumbing to the fatigue consequent upon extended flight.—[Prof. F. H. Snow, of Kansas State University, in *Observer of Nature*.

DEFINITION OF THE SPECIES.

In defining the Rocky Mountain Locust last year, I endeavored to show that we have three closely related forms or so-called species, viz.: *spretus*, which is the devastating species of the West; *femur-rubrum*, a somewhat smaller, shorter-winged species common over the whole country, and *Atlanis*, a still smaller species, but, except in size, approaching in general character nearer to *spretus* than *femur-rubrum*. Careful study of the subject has convinced me of the correctness of the definitions then given. In the report of the meeting of the Cambridge Entomological Club, already referred to, we are told that:

Mr. Scudder also doubted the specific and perhaps even the varietal rights of *C. Atlanis*, described by Mr. Riley from the White Mountains, for specimens of *C. spretus* have been found in different eastern localities, and, like many other insects of wide latitudinal distribution, have shorter wings than the western forms. Mr. Riley gives no characters of importance to distinguish *C. Atlanis* from *C. spretus*.

An opinion like this from one who has given much attention to the Orthoptera might command respect were it not unjust and superficial. All discussion at the present day as to whether we are dealing with species or varieties, is more or less puerile. Naturalists have no fixed standard as to what constitutes a species, and are fast coming to the conviction that there is no such thing in nature, and that

the term is conventional—an abstract conception. Yet it is the custom, in entomology and botany more particularly, to separate by names, under this term species, forms that are separable and show constant differences; and the separation of such by the study of large material, and their life-histories is of far more weight and value than that by the examination and description, however detailed, of one or two individuals. In giving my opinion that "the future orthopterist, as he studies material from all parts of the country, will very likely write: *Caloptenus femur-rubrum*, DeGeer., var. *spretus* Thomas, var. *Atlanis* Riley; but the broad fact will remain that these three forms —call them races, varieties, species, or what we will—are separable, and that they each have their own peculiar habits and destiny," (Rep. 7, p. 171,) I have, I think, indicated how very immaterial it is what rank in a system of classification they hold; but nothing is more certain than that typical specimens of each are at once distinguishable, and far more readily than the majority of species described in Entomology—and, let me add, than many of the species described by Mr. Scudder himself in the same Family and genus. If I should say that my friend "gives no characters of importance to distinguish" many of his species, I might be deemed rash; the following opinion, therefore, of Prof. Thomas, which I am permitted to publish, will have more weight. Prof. T. writes me: "Although the descriptions of species established by Scudder may be ample and sufficient in other orders; in *Acridii* I have, as a general rule, found them quite unsatisfactory. The characters chosen are those most liable to variation, and hence insufficient in describing species. As a natural consequence, a number of his species are in fact but varieties." As Prof. Thomas himself has confessedly, in his Synopsis of the Acrididæ, described several varieties as species,* it would seem that even if Mr. Scudder's opinion of *Atlanis* were just, I should simply be in the same boat with himself and the other authorities. Not to waste words, however, on what

* I am fully convinced that this has occurred even more often than he imagines; for unfortunately he rarely states the number of specimens described from, and although he relies more on structural than colorational characters as of more value and less variable, even they lose their value if founded on slight variation, when large material is examined. During the past year I have collected very largely of the commoner species in this Family, and I unhesitatingly assert that, with few exceptions, minute relative measurements of parts or minute colorational descriptions from a few individuals are of little value; and that in Calopteni particularly, specimens taken from the same locality show such variation, and so connect with other species through these variations, that there is no proper way of defining except by the average differences of large numbers. Not only would many supposed species vanish by this method, but many genera also; for I have good evidence to show that in several cases, species described under the genus *Pesotettix*, are but short-winged forms of *Calopteni*. In submitting some material for determination to Prof. Thomas, he writes: "You have assigned me a very difficult task in submitting to me for determination these erratic Caloptenoid forms. * * Stal's attempt to systematize, if carried out will give us a genus for nearly every species; and Scudder seems disposed to make a distinct species for each variation in color."

must remain a matter of individual opinion, I repeat that careful comparisons made during the year of many hundreds of specimens both living and dead, of *spretus*, *femur-rubrum*, and *Atlanis* fully establish in my own mind the justness of the separation of these three forms, and Prof. Thomas is of the same opinion. I have a box full of each now before me, and no one would for a moment hesitate to separate the typical, diminutive, livid, mottled and strongly marked *Atlanis* from the typical, large, pale, more uniform and voracious-looking *spretus*. Granted—as I freely have—that they approach each other through deviations from the average, as indeed most species do, I have yet to see the first specimen of *spretus* and *Atlanis* that I could not properly separate; and when Mr. Scudder is more familiar with the true Rocky Mountain *spretus*, he will give up his notion that it occurs in different localities in the East. All such statements result from confounding these two forms and the inaccuracy that such statements imply is good evidence of the necessity of designating the two forms by different names. Indeed *Atlanis* is more effectually separated from *spretus* than from *femur-rubrum*, for while it may be distinguished from this last by the characters which I gave a year ago, viz.: smaller size, more mottled coloring, relatively longer wings, and notched anus; and while aside from these characters, its brighter yellow venter permits its separation with great ease in life, the two forms more thoroughly blend by departures from the average, than do *spretus* and *Atlanis*. Thus, Mr. Thomas in speaking of them, writes:

So far all the *Atlanis* I have spread have the wings slightly tinged with blue when fresh, while this does not appear to be the case with the true *femur-rubrum*; it (*Atlanis*) also has the outer face of the posterior thighs more distinctly marked with alternate oblique dark and light bands, in these two characters agreeing very closely with my *C. occidentalis*, which is probably but a variety of *femur-rubrum*, as I am compelled also to think your *Atlanis* is. I might add also that I believe *Atlanis* usually has the hind tibiæ blueish, but this character is so uncertain that it is of little value.

I am inclined to think *femur-rubrum* the older form and that during the change which produced the desert condition of the west it was converted in that district into *spretus*. The *Atlanis* form I think is less permanent and more transient, the result probably of suitable climatic conditions continued but a few years, and that as soon as the climate returns to the normal condition it will revert to the usual form of *femur-rubrum*. My *C. occidentalis* belongs chiefly to that region and climate found in Northwestern Minnesota and Eastern Dakota.

Not having previously taken specimens of *Atlanis* in Missouri, I formerly inferred that it was confined to the mountain regions of the Atlantic. In 1875 I collected it in large numbers in St. Louis, Jefferson, Washington, St. Charles, Warren, Franklin, Boone and Cole counties in Missouri, and in various parts of Illinois. I found it associated with *femur-rubrum*, and often in equal numbers; and this in two instances in the same fields in which the year before I had collected hundreds of specimens of nothing but *femur-rubrum*.

In this connection I will also record the occurrence of a variety of *spretus*, in which all the pale or normally yellowish-gray parts are bright green. These green individuals are conspicuous among their brown brethren. I found them to constitute about one in a thousand of the schools around Warrensburg, and singularly enough nowhere else. The green endures from the larva to the perfect state, and I would designate this variety as *viridis*. It is but a marked colorational variety, in a species which has not heretofore been known to present these colorational differences, and no one having a true conception of the differences between *spretus* and *Atlanis* would think of placing the latter on the same grade.

Comparisons of the immature stages of these three species show that, when large material is examined, *femur-rubrum* and *Atlanis* are more nearly allied than this last and *spretus*, though, as in the mature insects, they approach each other through exceptional individuals.

In the first stage, *spretus* has a decidedly ferocious look, the head being out of all proportion to the rest of the body. The colors are brown, gray and dull white, the general tint being light gray, and the insect presenting a mottled and speckled appearance. The antennæ have several joints less than when mature, and are more thick and clavate. The frontal ridge is more prominent and deeply sulcate. The cerci extend beyond the rounded tip of the abdomen. The tarsi show the three joints, but the middle one less distinctly than afterwards. The medio-dorsum from vertex to near the tip of the abdomen, is carinate and pale. Of the dark dots and marks the most conspicuous and persistent (for some specimens are much darker than others) are, one behind the eyes, a sub-quadrate one on the side of the meta-thorax, a crescent streak on the sides of the swollen end of hind femora, and two spots on the bulbous base of hind tebiæ. In the second stage the face with very rare exceptions is pitchy black, the top of the head shows the three characteristic rows of transverse black marks on a rust-brown ground, the outer rows curving around the eyes, and the middle one broadest and divided by a narrow medial, pale line; the rust-brown color continues, with more irregular black marks on the prothorax, narrowing toward its middle; on each side of it the anterior part of the prothorax is black, relieved below by a conspicuous, arched pale line, and this again with a more or less distinct dark lateral mark beneath. The cheeks are mottled with rust-brown and edged behind with yellow; the head beneath, and palpi, except a black rim around tips are pale yellowish. The other colors are much as in the mature insects. With each succeeding stage the broad and pale streaks of prothorax intensify, and as soon as the hind wing-pads are turned up over the front pair, viz: in the third stage, the pale spot at the base which becomes so conspicuous in the pupa, is visible. The black face after the first molt is quite characteristic, and often endures to the pupa state.

Atlanis, in the first stage, is distinguished by its deeper, more livid, or rosy, less speckled appearance, and more strongly contrasting brighter yellow venter. In the subsequent stages these colorational differences still prevail and the face is not black as in *spretus*; the pale spot on the hind wing-pads is less conspicuous in the third, and the pupa is not only distinguished by its smaller size and different color, but by the narrower, more obsolete black marks of the prothorax and by the wing-pads being con-

siderably shorter and smaller, the hind pair livid, with only rarely a touch of black at base, and with the pale spot obsolete. It presents in fact a marked contrast to the pupa of *spretus*. In the early stages, *femur-rubrum* is distinguished from *Atlanis* by no very constant characters, except the generally paler, less livid and greener hue.

As the idea prevails among many of our farmers that our Rocky Mountain Locust is identical with the devastating species of the Old World, and Mr. Z. S. Ragan, in an otherwise excellent essay, read at the last meeting of our State Horticultural Society, gives it as his opinion that our locusts "came over from Asia via Behring's Strait, to British America, thence extended from time to time over Washington Territory, Oregon, California, Utah, Idaho, Montana, Wyoming, Dakota, Nevada, Colorado, Arizona, New Mexico, Texas, Kansas, Indian Territory, Nebraska, part of Missouri, Iowa, Minnesota and Wisconsin;" it may be well to insist here that there is no foundation whatever for such an opinion, and that *spretus* is a purely American species, occurring in no part of Europe or Asia.

EXPERIENCE IN THE SPRING.

Having already spoken of the desolate aspect which the ravaged country wore toward the end of June, it will suffice in this connection to give a few of the more interesting experiences. It is recorded in Europe that few things, not even water, stop the armies of the young locusts when on the march, and Döngingk relates having seen them swim over the Dnjestr for a stretch of 1¼ German miles, and in layers 7 or 8 inches thick.* We have had similar experience with our own species. Mr. James Hanway, of Lane, Kansas, informs me that the young last Spring crossed the Potawotomie Creek, which is about four rods wide, by millions; while Mr. Z. S. Ragan, of Independence, told me that the Big and Little Blues, tributaries of the Missouri, one emptying into it above and the other below his place, the one about one hundred feet wide at its mouth, and the other not so wide, were crossed at numerous places by the moving armies, which would march down to the water's edge, and commence jumping in, one upon another, till they would pontoon the stream, so as to effect a crossing.

A neighbor also informed him that two of these mighty armies met, one moving east and the other west, opposite his farm, on the river bluff, and each turning their course north, and down the bluff, and coming to a perpendicular ledge of rock twenty-five or thirty feet high, passed over in a sheet, apparently six or seven inches thick, and causing a roaring noise similar to a cataract of water.

* Köppen, *loc. cit.*, p. 43.

It was generally supposed that evergreens would escape the ravages of the young insects, but wherever these were abundant, hemlock, arbor vitæ, the different pines, and especially the Norway spruce, for which they showed a predilection, were stripped. The red cedar more often escaped. Wild prairie, especially that which was low, would be eaten down less closely than other grasses, and oats more often escaped than other cereals. Blue grass was sometimes killed out, but more generally not, and corn was eaten down so often and so deeply into the ground that it was frequently destroyed. Potatoes were not killed by being eaten down and very generally made a crop after the insects left, without replanting. This was especially the case where planted deep and where the vines as they grew were at first kept covered with earth, which they can be with impunity. The blossoms and stems of peas were left after the leaves were stripped, and parsnips sometimes remained untouched. All other vegetables were swept off. Of wild plants, Milkweed (*Asclepias*) and Dogbane (*Apocynum*) were little to their taste, and only taken when all else was destroyed; an occasional *Salvia trichostemmoides* and *Vernonia novæboracensis* would also be left in the general ruin; but the plant of all others that enjoyed immunity from the omnivorous creatures was the *Amarantus Blitum*, a low, creeping glossy-leaved herb, lately introduced into the State. I found this plant unmolested even where the insects were so hard pushed for food that they were feeding on each other and on dead leaves, the bark of trees, lint of fences, etc., and where they were so thick hiding amid its leaves that fifty to a hundred occured to the square foot. The immunity of the plant is the more remarkable since the other species of the genus do not escape.

CONTRAST IN SUMMER AND FALL.

By the end of July the whole ravaged district began to wear a smiling and promising aspect, in strong contrast to the desolation of a month before. In Missouri, in the non-ravaged districts, the wheat harvest was interfered with by the exceptionally heavy rains that prevailed at the time; but in most other parts of the country within the locust district the reports were most encouraging. In Minnesota the crops in the counties ravaged in 1874 yielded well. In Dakota the crops of wheat, oats and barley were reported, around Yankton, as promising to be the best ever harvested. In Colorado everything looked splendid, after the locusts left. The people of Iowa and Kansas, in general, were jubilant over their brightened and encouraging prospects, though, as in Missouri, the heavy rains retarded and somewhat reduced the grain harvest. In Indian Territory the wheat crop was reported as the largest ever gathered in that part of the country. In August the contrast became still more gratifying, and in our own

stricken counties the finest crops the people had witnessed for years, were reported, of corn, Hungarian grass, prairie meadow, buckwheat and vegetables of all kinds. Larger areas had been planted to corn than ever before. In September the change which three months had wrought needed to be seen to be appreciated, and never in the history of those counties had root crops done so well, or vegetables of all kinds attained such immense proportions.

NO EVIL WITHOUT SOME COMPENSATING GOOD.

Not to mention the valuable experience and the quickening influence that are generally gained in temporary adversity, there are other ways in which good will grow out of the locust troubles. The chinch bugs filled the air last Spring throughout the stricken district, and many persons feared that they would destroy the corn crop even if the locusts left. I then argued that there was no danger of such a result, and that there was every reason to expect less injury from this cause than usual, and with a wet Summer, which might be expected, an almost total annihilation of the pest. With everything eaten by the locusts, the female chinches, instead of being quietly engaged, unseen, in laying eggs, as they usually are in May, were flying about, seeking plants on the roots of which to consign their eggs. For this reason they were more noticeable. Once fully developed in the ovaries, and the eggs must be laid, and the great bulk of them were necessarily laid where the young hatching from them were destined to perish, as the result proved; for, injurious as the species had been for the two or three previous years, scarcely a specimen was to be found in the Fall. Indeed, I think we may safely conclude that, as a consequence of the locusts and the rain, the farmers of our western counties will not suffer from the Chinch Bug for the next two years at least. The same will hold true of many other insect pests, which were starved out last Spring; and while some of our common native locusts were so thick in the Fall, in the eastern portion of the State, as to do serious injury to fall wheat and garden truck, scarcely one could be found in the counties most ravaged last Spring by the *spretus*.

The unusual productiveness of the soil in the stricken country was on all hands noted during the year, and was owing, in no small degree, to the rich coating of manure which the locusts left. In the form of excrement and dead locusts, the bulk of that which was lost in Spring was left in the best condition to be carried into the soil and utilized. The introduction of new seed from other States was also beneficial.

Nature generally maintains her averages, and whenever diminished southern winds, drouth and locusts have prevailed, the opposite conditions are very apt to follow, and give us plenteous harvests in the place of short crops.

INJURY TO FRUIT AND FRUIT TREES.

It is doubtful if grain-growers and stock-raisers suffered as much in the end as fruit-growers, from the locust injuries. The injury was less felt by these at the time, but was in many instances more lasting and serious. Most trees would survive one or two defoliations, but in many cases no leaves were permitted to grow for weeks, just at the season when they are most needed. This was especially the case with low shrubs, such as gooseberries and currants, in which the insects were fond of roosting. Where not excessively numerous, heart-cherries were preferred over others, and the insects would pass through a strawberry bed and only clean out the weeds. A great many trees were killed outright, and it was often found necessary to cut down the grape-vines. Trees not killed were often badly barked and lost many limbs, except where protected by ditches no orchards yielded fruit. Many trees put forth a few secondary blossoms after the insects left, and a few small apples were noticed on such in autumn.

FOOD PLANTS.

I have little to add to what was said under this head last year. The Minnesota Commission found that the bearded varieties of wheat escaped with less damage from the winged insects than smooth varieties, owing as they think to the fact that the insects are deterred by the long beards from attacking the heads, and confine their injuries to the stalks and leaves. Mr. G. M. Dawson, in his "Notes" already cited, suggests that to their known dislike of Leguminous plants we may perhaps attribute the large number of such found on the western plains. The *Amarantus Blitum* is the only plant which I found the insects to refuse last Spring, when driven to extremities.

CHANGES THAT FOLLOWED THE LOCUSTS.

The invasions into a country of large numbers of animals, whether men or insects, are often followed by changes in the vegetation of that country. Certain strange plants are said to yet mark the path through the Southern States which Sherman's soldiers took in their march to the sea, and a number of plants new to the country are known to have been introduced into France by the Germans during the late Franco-Prussian war. So the locust incursions and devastations in Kansas and Missouri were followed by some curious changes. These changes

consisted mostly in the great prevalence of plants that in ordinary seasons are scarcely noticed. The *Amarantus Blitum* already spoken of spread at an unprecedented rate, and grew in great luxuriance. Immediately after the locusts left, the common purslane started everywhere and usurped the place of many other species. The common nettle (*Solanum Carolinense*), and the sand burr (*S. rostratum*),

[Fig. 42.]

a a

Green Larva of White-lined Morning Sphinx.

spread to an alarming degree, and the Pcke weed (*Phytolacca decandra*), was very abundant. All kinds of grasses grew very luxuriantly during the Summer, a fact due to the wet and favorable weather; but some kinds * that are rare in ordinary seasons, got the start and grew in great strength and abundance. Among these none are more notable than the sudden appearance very generally over the locust-devastated region, of what is usually called a new grass. Springing up wherever the blue grass gets killed out it proves a God-send to the people, for while it is young and tender cattle like it and fatten upon it. This grass is the *Vilfa vaginæflora*, an annual which

[Fig. 43.]

b

Black Larva of White-lined Morning Sphinx.

is common from the Atlantic to the Rocky Mountains. Unnoticed during ordinary seasons, the destruction of the blue grass and other plants by the too close gnawing of the locusts, gives it the advantage in the struggle for existence—an advantage which is soon lost, however, as the normal relations between species are assumed again in a few years after the disturbing influence has ceased to be operative.

* Prof. G. C. Brodhead (Trans. St. Louis Ac Sc. III, p. 348) mentions more particularly, *Aristida oligostachya*, in ordinary seasons of rare occurrence around Pleasant Hill, as reaching the unusual height of two feet, and being very abundant. *Eragrostis poæoides*, ordinarily recumbent and scarcely noticed in yards and along roadsides, grew in profusion and 3½ feet high, "looking like meadows ready to be mowed." *Panicum sanguinale* was luxuriant enough to cut for hay.

Indeed, since the Vilfa ripens and dies early in the Fall, the blue grass gains ground the very first year, and afterward easily retains supremacy. The wide-spread appearance of the Vilfa, following the locusts, has been explained on the hypothesis that the latter brought the seed from the West and passed it undigested with their droppings. The fact that the seed is a line long, and not particularly hard, aside from the other facts in the case, renders such a hypothesis unreasonable. Being an annual, the seed was scattered the previous Fall, and naturally starting, we may presume, about the time the insects left, the species got the ascendency.

Some persons were quite alarmed at the prevalence of large green and black worms, soon after the locusts left. Feeding upon purslane and prevailing to an unusual degree, because of the unusual prevalence of this plant, they generally did good by keeping this weed down and converting it into manure. In some few instances, however, they swarmed to such an extent as to devour all the purslane, when they attacked grape-vines, and as Mr. Thos. Wells, of Manhattan, Kansas, informs me, even cut off corn when it was about a foot high. These worms were the variable larvæ of the White-lined Morning Sphinx, a pretty moth often seen hovering over flowers at evening. The species was treated of in my third Report (p. 140) and the illustrations are herewith reproduced. Most insects that naturally feed in Spring above ground on low vegetation were killed out, and the only species unaffected by the visitation were those feeding on forest trees, or living in the ground or in the trunks of trees. The White-lined Morning Sphinx, was just issuing from the pupa, which had remained undisturbed below ground, when the locusts were leaving. It found the purslane—its favorite food-plant—everywhere springing up and abundant, and its eggs were laid without difficulty, and the young larvæ did not, in any case, lack for food. As a consequence they prevailed to a remarkable degree.

[Fig. 44.]

White-lined Morning Sphinx.

THE LOCUSTS DID NOT RETURN IN THE FALL.

In the scourged district the people were very anxious lest another invasion like that of the previous year should occur. I did not hesitate to insist through several journals that there was no danger of a general invasion. None of the insects were noticed to return in autumn in Iowa and Nebraska, and though there are authenticated instances of a few scattering individuals, or of small swarms flying over parts of Kansas and Missouri, and settling without doing damage, yet in the majority of instances thistle down and the downy portion of cottonwood seed, were proved to be the occasion of the reports that were made of flying locusts.

The specimens I have obtained of these returning individuals are like those which developed in the same territory during the Spring, i. e. somewhat darker and below the average size of the typical species; which indicates that they did not come from the extreme northwest, but more probably from nearer home, and perhaps from Colorado. In September a few flights also came into Texas from the north.

As a rule the ravaged districts were remarkably free in the Fall of most insects and especially of locusts. Those individuals that did not get away in June were, as one of my correspondents, Mr. J. Coen, of Jackson Station, remarks "loaded with parasites and soon died;" while the native species were scarce.

NATURAL ENEMIES.

I have no important additions to make to the list of these instanced last year. The good offices of birds were everywhere noticed, and Mr. Wise, of the Minnesota Commission, is of opinion that the blackbirds and prairie chickens destroyed a large portion of the eggs laid in that State in 1875, scratching for them after the fashion of hens. Prof. F. H. Snow, of Lawrence, Kansas, found the young locusts in the gizzards of the Red-eyed Woodpecker (*Melanerpes erythrocephalus*,), Yellow-billed Cuckoo (*Coccyzus Americanus*), Cat-bird (*Mimus Carolinensis*), Red-eyed Vireo (*Vireo olivaceus*), Great-crested Flycatcher (*Myiarchus crinitus*) and Crow Blackbird (*Quiscalus versicolor*), species that had not been noticed to feed on them before. I found the young insects in our own counties pursued by many predaceous beetles, especially those (p. 52) that attack the Army Worm. I also found several species of predatory soldier-bugs attacking them; and Mr. Dan. Carpenter, of Barry, refers, by letter, to the frequency with which the locusts in his neighborhood were noticed to be infested with "slender worms measuring often fourteen to eighteen inches in length," which were without doubt hair-worms, (*Gordii*)—well

known to infest several other species of Calopteni. None of these enemies are so effectual in their work as the mites and Tachina-flies.

REMEDIES AGAINST THE UNFLEDGED INSECTS.

The war waged against the young insects last Spring was energetic and untiring, and everything that human ingenuity could conceive was employed in the conflict. Trapping, burning, tramping, poisoning, trenching, were all resorted to. In some cases whole acres were surrounded with boards and the insects imprisoned until they starved, while in others coal tar was smeared on to fences and out-houses in order to hold fast the newly-hatched swarms that settled thereon.

The means to be employed against the ravages of this insect in the more fertile country subject to its periodical visitations, but in which it is not indigenous, may be classed under five heads: 1. Natural agencies; 2. Artificial means of destroying the eggs; 3. Such means of destroying the unfledged young; 4. Remedies against the mature or winged insects; 5. Prevention. Having considered these measures last year, I shall treat here principally of the second, third and fifth, bringing together the more valuable experiences of the year. In a paper on "The Locust Plague: How to avert it," read before the American Association for the advancement of Science last August, I wrote as follows:

Artificial Means of Destroying the Eggs.—The fact that man can accomplish most in his warfare against locusts by destroying the eggs has long been recognized by European and Asiatic governments liable to suffer from the insects. The eggs are laid in masses, just beneath the surface of the ground, seldom to a greater depth than an inch; and high, dry ground is preferred for the purpose. Very often the ground is so completely filled with these egg masses, that not a spoonful of the soil can be turned up without exposing them, and a harrowing or shallow plowing will cause the surface to look quite whitish as the masses break up and bleach from exposure to the atmosphere. Great numbers will be destroyed by such harrowing or plowing, as they are not only thereby more liable to the attacks of natural enemies, but they lose vitality through the bleaching and desiccating influence of the dew, and rain, and sun. If deeply turned under by the plow, many of them will rot, and the young that chance to hatch will come forth too late the next year to do much harm—providing the same ground be not re-turned so as to bring the eggs to the surface in the Spring.* Excess of moisture for a few days is fatal to the eggs, and they may very easily be destroyed where irrigation is practicable.† Where stock can be confined and fed on soil filled with such eggs, many of these will be destroyed by the tramping. All these means are obviously insufficient, however, for the reason that the eggs are too often placed where none of them can be employed. In such cases they should be collected and destroyed by the inhabitants, and the State should offer some inducement in the way of bounty for such collection and destruction. Every bushel of eggs destroyed is equivalent to a hundred acres of corn saved, and when we consider the amount of destitution caused in some of the Western States by the locust invasion of 1874, and that in many sections the ground was known to be filled with eggs; that, in other words, the earth was sown with the seeds of future destruction—it is surprising that the legis-

*The beneficial results of plowing under or turning up the eggs are fully demonstrated in the report of the Minnesota Commission.

†The efficacy of irrigation or inundation in destroying the eggs will, of course, depend very much on the character of the soil, and may be of little service in a tenacious clay.

latures of those States did not make some effort to avert future injury by offering a liberal price per bushel for the eggs A few thousand dollars taken out of the State treasury for this purpose would be well spent and be distributed among the very people most in need of assistance.

Destruction of the Unfledged Young.—As I have stated in the articles already alluded to, heavy rolling, where the surface of the soil is sufficiently firm and even, destroys the larger portion of them, but is most advantageously employed when the insects are most sluggish. They drive almost as readily as sheep, and may be burned in large quantities by being driven into windrows or piles of burning hay or straw. But the experience of the present year convinces me that by far the most effectual way for man to protect his crops and do battle to these young locust armies—especially where, as in West Missouri, last Spring, there was no hay or straw to burn—is by ditching. A ditch two feet wide and two feet deep, with perpendicular sides, offers an effectual barrier to the young insects. They tumble into it and accumulate, and die at the bottom in large quantities. In a few days the stench becomes great and necessitates the covering up of the mass. In order to keep the main ditch open, therefore, it is best to dig pits or deeper side ditches at short intervals, into which the hoppers will accumulate and may be buried. We hear much talk about the powerlessness of man before this mighty locust plague; but I am quite confident that here we have a remedy that is at once thorough and effectual, whereby the people of some of the States, at least, may avert in future such evil as that which befell them this Spring. There have been a number of partial attempts at ditching by simply turning a couple of furrows with the plow. Even these will often divert the encroaching insects from their course; but they can never be relied on, and you may rest assured that whenever you hear a man declare that ditching is no protection, he refers to such slovenly, half-made ditches. No instance has come to my knowledge where a ditch, such as I first described, has failed to effectually keep off the insects. Made around a field about hatching time, few hoppers will get into that field till they acquire wings, and by that time the principal danger is over, and the insects are fast disappearing. If any should hatch within the inclosure, they are easily driven into the ditches dug in different parts of the field.

Just behind the fair-grounds at Kansas City there is an intelligent and industrious gardener, Mr. F. D. Adkins, having about three acres in vegetables. The locusts hatched in large numbers all around Kansas City, and nowhere more abundantly than in the immediate vicinity of this truck-garden. Mr. Adkins, remembering his experience with the same plague in 1867, persevered in ditching for their destruction in 1875; and though the surface of the country for miles and miles around was desolate, yet this little three-acre field was untouched—a perfect oasis in the desert, at once giving pleasure to the eye and speaking eloquently of what may be accomplished by a little tact and perseverance. Rush Bottom, in Jackson county, contains a large tract of land in a bend of the Missouri river, naturally protected on all sides but one by the river, and Mr. Ragan relates that, taking advantage of this circumstance, the inhabitants cut a ditch across the neck of land at the foot of the bluff—cutting off the marching column of locusts from the surrounding country. They thereby saved their gardens and hundreds of acres of corn and oats.

Mr. S. D. Payne, of Kasota, Minn., says in the Report of the Minnesota Commission: "In my mind the most practical mode, not only of protecting the crops but of destroying the plague, is the ditching system. I have demonstrated to my own satisfaction that an individual farmer can protect himself both against those bred on his farm (by carefully noting the breeding-grounds and the consequent points

of invasion) and those raiding from the neighboring country; and a general concert of action by all the farmers will tend to vastly decrease the numbers, if not entirely remove those hatching here." Numerous other instances of this kind might be given, and I have not a doubt but that with proper and systematic ditching early in the season, when the insects first hatched, everything could have been saved with comparatively little trouble. I have seen people driving off the young locust day after day, in their endeavors to save some small vegetable or flower garden—their efforts eventually in vain—where one-tenth the time spent in ditching would have effectually accomplished the object. And when I should, perhaps, have been praying, I have witnessed sights that prompted to thought and word the very reverse of prayer. In a large portion of Johnson county the injury was slight, and until the end of May little damage was done around Warrensburg. Happening to be in the vicinity of this town on the 3d inst., I came upon a beautiful vineyard which had up to that time escaped. The insects had got into it, and the owner was advised to ditch to save it. His piety exceeded his good sense, however, and instead of genuflecting on a spade he was performing the operation in another way, while his beautiful vineyard was literally being gobbled up at a rate that would not show a green leaf by the morrow. I respect every man's faith, but there are instances where I would respect his work a good deal more.

Where water can be let into the ditches so as to cover the bottom they may be made shallower, and still be effective. Mr. Frank Holsinger, of Kansas City, under date of May 23rd, 1875, sent me the following account of his experience:

Your very interesting communication to the St. Louis *Globe* was reproduced in our *Journal of Commerce* of the 21st inst. I have no doubt but that your counsel will be heeded by many, but to the mass of our people it is as "sounding brass," etc. During the past four days I have been at work, and although I spent less than one-fourth of my time to the purpose, I have destroyed between 30 and 40 bushels of wingless locusts. My remedy is so simple I concluded to give it to you, as I think it better than any I have yet seen, and had I known how easily it was to accomplish I would now see growing crops where ruin and desolation appear.

As they had entered my wheat (I took your advice and Fall-plowed everything, and I do not think there was a hatfull hatched on my 40 acres) from neighboring farms, and knowing that when they got through they must move in force on my garden, I cautioned my wife to inform me when they commenced on this last. On the 18th inst., at 11 A. M., she gave the watchword, "they come;" so, leaving corn-plowing, I hastened to surround our garden with a board fence, intending to drive the insects around, but to no purpose, although the boards were placed at 45° outward, and some six of us were at work. Still they came. We built straw fires next—still unsatisfactory. I had been underdraining, and had some drains still open. Wife said, "you will work yourself sick, and all to no purpose." I take a look, and a patch of early potatoes, one-third of an acre, which we had saved, was melting before them. I then saw them march straight for the drain. My impulse then was to burn them in the drain. This I found difficult. The next thought was "pit-falls at intervals in the drain;" I commenced digging these, and the locusts tumbled in by thousands, but many escaped. Now the thought occurred that if there was water in the pits they *could not jump;* so water was thrown in, and the result was a success. I feel certain that by a judicious expenditure of $50, in ditching around my 35 acres, I could have saved everything, while my loss is largely in excess of $1,000.

The width and depth of the ditch is important, and as experience differed somewhat I have been at pains to get the experience of a large number of correspondents addressed by circular. Many successfully used ditches 2 feet deep and 18 inches wide; a few made them only 18x18; those who used water found 12x15 sufficient, while the larger number used a ditch such as I have recommended, viz.: 2 feet deep by 2 feet wide, with perpendicular sides. At the winter meeting of the Kansas State Horticultural Society, Dr. J. Stayman, of Leavenworth, insisted that a ditch 3 feet wide had not prevented the insects from crossing on his place. Thinking that his experience, so different to that of the majority of his own people, might be accounted for by the character of his soil and other circumstances, I got him to promise to send me a detailed statement, and to give me the similar experience of others, which he asserted he could do; but I have not heard from him since. Mr. Jas. Hanway, an intelligent correspondent of the *Kansas Farmer*, and who, at my request, has been to some trouble to get the experience of Kansans on this point, writes that the ditches generally made were from 18 to 20 inches wide, and about 12 inches deep. Professor Thomas is of opinion, from what he has seen in Colorado, that while a ditch such as I have recommended will prevent the larvæ from crossing, "the pupæ, though halting for a time, will soon make the leap." That they *can* do so, every one who has had experience knows; and so can the larvæ; but the fact remains, as I had abundant evidence last Spring, that in practice they seldom do when hatching out in our part of the country, and that even when the majority are in the pupa state, the 2-foot ditch is still quite effectual. Even the larger winged Acridii and Œdipodæ tumble into such a ditch, and seldom get out again. I would remark in this connection, also, that a ditch 3 feet wide, unless correspondingly deep, will be more apt to permit the insects to escape, when once in, than a narrower one. In hopping, the more perpendicular the direction the insects must take the shorter will be the distance reached. Whenever our farmers are again troubled with the unfledged myriads, the 2-foot ditch, used in time, will be found all sufficient.

Next to ditching the use of nets or seines, or converging strips of calico or any other material, made after the plan of a quail net, proved most satisfactory. By digging a pit, or boring a post augur hole, 3 or 4 feet deep, and then staking the two wings so that they converge toward it, large numbers of the locusts may be driven into the pit after the dew is off the ground. By changing the position of this trap, much good can be done when the insects are yet small and huddled in schools; but all modes of bagging, netting and burning become

comparatively useless when the insects begin to travel in concert over wide stretches of land. The same may be said of all mechanical contrivances to facilitate the destruction of the insects: they are useful if used in concert in a given neighborhood soon after the young hatch, but subsequently do not compare to ditching. Mr. Charles D. Zimmerman, of Buffalo, N. Y., has sent me the plan of an immense bag, by which he found that he could catch large quantities of native species. To a frame 15 feet long and 3 feet high is tacked a stretch of cheap cotton cloth. The stuff is closed at the ends, and when the frame is mounted on wheels, and drawn across a meadow, the locusts accumulate in the bag which drags on the ground, and there form a tangled mass and do not escape. The same style of bag, on a larger scale and drawn with a horse at each end, and with an arrangement whereby the lower edge of the bag could be unhooked from the frame and the accumulated insects dumped into pits, would prove useful. Mr. J. Hetzel, who has had considerable experience at Longmont, Col., writes me that the best means he has seen of fighting the locusts, if they do not hatch on the ground, is a burner drawn by horses. "It is 12 feet long, 2 to 2½ feet wide and made of iron, set on runners 4 inches high. An open grate on the top of the runners is filled with pitch pine wood, and a sheet covers the grate to keep the heat down. Two men and a team will burn 10 to 12 acres a day, and kill two-thirds of the insects, but it requires a hot fire." Mr. C. C. Horner gives in the *Colorado Farmer* the following more detailed description of what appears to be the same machine:

It consists of three runners made of 2x4 scantling three feet in length, to be placed six feet apart, making the machine twelve feet wide, runners to be bound together by three flat straps or bars of iron (the base being 12 feet long.) Across the top, bars of iron hold the runners firmly together and form a frame across which wire can be worked, to make a grate to hold fire. The upper part of the runners should be hollowed out so that the grate may glide along within two inches of the ground. A sheet iron arch should be set over this grate to drive the heat downward. This machine is very light and can be worked with one horse; pitch-wood is best adapted for burning and can be chopped the right length and size and left in piles where most convenient, when needed. This machine is intended to be used when the little hoppers just make their appearance along the edge of the grain, going over the ground once or twice each day, or as often as necessary to keep them killed off. The scorching does not kill the grain but makes it a few days later. This is certainly the cheapest manner of getting rid of this pest, as well as the most effectual.

Mr. Rufus Clark, of Denver, according to the same paper, uses a piece of oil cloth, nine to twelve feet long, and six feet wide; one side and each end is secured to light wooden strips by common carpet tacks, and the corners strengthened by braces.

"The oil cloth is smeared with coal tar, purchased at the Denver Gas Works for $7.50 per barrel, and the trap is dragged over the ground by two men—a cord about ten feet long being fastened to the front

corners for that purpose. The entire expense of the "trap" is about $3.50, and as it is light and easily handled will be found serviceable on small as well as large farms."

Zinc instead of oil cloth has also been used for the same purpose.

The experience of last Spring shows that when the insects are famishing, it is useless to try and protect plants by any application whatever. Sweetened water seemed to keep the winged insects off special plants in 1874; but it certainly has no such effect on the unfledged hoppers, for they "went for" plants which I thus sprinkled even more voraciously than for those not sprinkled. Lime does not deter them; neither coal oil nor cresylic soap will keep them from eating; and Paris green, though it undoubtedly kills those which partake, is yet no protection to plants, because those which go off to die somewhere after partaking are continuously followed by others which go through the same experience. I gave carbonic acid gas, from a Babcock fire extinguisher, a thorough trial under many different circumstances and conditions, but without any satisfactory results. It had very little effect upon them even when played upon them continuously and at short distance. They often became numbed by the force of the liquid but invariably rallied again.

The best means of protecting fruit and shade trees deserves separate consideration. Where the trunk is smooth and perpendicular, they may be protected by whitewashing. The lime crumbles under the feet of the insects as they attempt to climb, and prevents their getting up. By their persistent efforts, however, they gradually tear off the lime and reach a higher point each day, so that the whitewashing must be often repeated. Trees with short, rough trunks, or which lean, are not very well protected in this way. A strip of smooth, bright tin answers even better for the same purpose. Encircling the tree in any of the different ways suggested for preventing the ascension of the female Canker Worm, puts an effectual estoppel on the operations of the young locusts above the point of attachment, for they cannot jump on a perpendicular surface. A strip of tin three or four inches wide brought around and tacked to a smooth tree will protect it; while on rougher trees a piece of old rope may first be tacked around the tree and the tin tacked to it so as to leave a portion both above and below. Passages between the tin and rope or the rope and tree can then be blocked by filling the upper area between tin and tree with earth. The tin must be high enough from the ground to prevent the hoppers from jumping from the latter beyond it; and the trunk below the tin, where the insects collect, should be covered with some greasy or poisonous substance to prevent girdling. This is more

especially necessary with small trees; and kerosene or whitewash having Paris green mixed with it will answer as such preventives.

One of the cheapest and simplest modes employed last Spring was, to encircle the tree with cotton batting into which the insects would entangle their feet, and thus be more or less obstructed. Strips of paper covered with tar, stiff paper tied on so as to slope roof-fashion, strips of glazed wall-paper, thick coatings of soft soap, were used with varying success; but no estoppel equals the bright tin; the others require constant watching and renewal, and in all cases coming under my observation some insects would get in to the trees so as to require the daily shaking of these morning and evening. This will sometimes have to be done when the bulk of the insects have become fledged, even where tin is used; for a certain proportion of the insects will then fly into the trees. They do most damage during the night, and care should be had that the trees be unloaded of their voracious freight just before dark.

One of my correspondents, Capt. John R. Wherry, of Boonville, has suggested the use of strips of canvass, dipped in liquid sulphur and attached to stakes to be stuck in the ground. He thinks that if the strips are lit at evening the fumes will drive the insects away from the locality they pervade. The suggestion strikes me quite favorably as a means of protecting orchards, and I would recommend its trial to the people of Colorado and the Mountain region, who will doubtless have the opportunity the present year. The strips should be dipped in hot sulphur, allowed to cool, and then staked to the windward of the orchard, if the wind is stirring.

HOW TO AVERT THE LOCUST INJURIES: PREVENTION.

The measures so far recommended have in view the destruction of the insects when once they are upon us. The question very naturally arises, "Can something not be done to prevent the incursions of the species into the more fertile States in which it is not indigenous?" In the previously quoted paper read at Detroit, I gave it as my opinion that "the proper way to deal with this insect is to attack it in its native breeding places. It is a fact that does not speak well for some of the countries of the Old World subject to locust injuries, that it is to this day not known whence many of the devastating swarms have their origin. But because European nations have hitherto shown lethargy on this subject, it is no reason why we should. Let us rather in this, as we have in many things, set an example which they will be glad to follow. * * * Our efforts should be confined to the restriction of the species within its natural limits.

The most important results are likely to flow from a thorough study of the Rocky Mountain Locust in its native haunts and breeding places. By learning just when and how to strike the insect, so as to prevent its undue multiplication there—whether by some more extensive system of irrigation, based on improved knowledge of the topography and water supply of the country, or by other means of destroying the eggs—we may hope to protect the fertile States to the East from future calamity."

One of the best means of checking the increase of the species in its native haunts, will be found in the encouragement and increase of its natural enemies, especially the game birds, and the example of Kansas should be followed in enacting stringent laws for their protection. The introduction of the English sparrow has been recommended. From what I know of the bird both here and in its native country, I should expect little aid from it in this line, and if it can thrive to the northwest, it will soon spread there, as it is rapidly multiplying at several points along the Mississippi. We may expect more good from the encouragement of native Locust-feeding species. Prof. Thomas has suggested that inducements be offered to the Indians to collect and destroy the eggs and young along the west side of the plains. Some system of preventing the extensive prairie fires in Fall that are common in the country where the insect naturally breeds, and then subsequently firing the country in the Spring after the young hatch and before the new grass gets too rank, might also be adopted. But whatever the means employed, they must be carried on systematically and on a sufficiently extended and comprehensive scale; and this brings me to the subject of

LEGISLATION, BOTH NATIONAL AND LOCAL.

It is very evident that if anything can be done at all in averting this evil, it must be done by national means. No one individual can acquire the requisite knowledge. The importance of having the matter properly investigated by the national government has been repeatedly urged by many prominent persons in the west, best competent to judge. The feeling has been very general of late years, both among scientific men and intelligent agriculturalists, that the work of our Agricultural Department, in the line of economic entomology, has fallen very far short of the expectations of the people. Whether this is owing to the character of its present management, or to the nature of the Department organization, is immaterial in this connection. The feeling has found expression in our agricultural journals, and in resolutions passed by various agricultural and horticultural

societies. These resolutions have lately assumed the more substantial form of a memorial, indorsed by several important agricultural and horticultural societies, and signed by many prominent farmers, fruit-growers and scientific men, urging Congress to create a commission that shall have for its object a thorough investigation of the principal insect pests of our agriculture, and particularly the one in question.

Two bills have, in consequence, been introduced during the present session of Congress, and referred to the Committees on Agriculture.

The first (Senate bill 158) was introduced by Senator Harvey, of Kansas, and appropriately referred in the Senate; it was subsequently introduced in the House by Mr. Patterson, of Colorado, and there properly referred. It is entitled "a bill to provide for an investigation as to the habits of the Rocky Mountain locusts, or so-called grasshoppers," and provides as follows:

That the Commissioner of Agriculture be authorized and requested to appoint three commissioners, having the requisite scientific knowledge to constitute a competent commission, whose duty it shall be to visit the native breeding places of the said locusts, in the Rocky Mountains or elsewhere; and report as to the best method of preventing the incursions or irruptions of the said locusts into the adjacent fertile States and Territories.

That the Treasurer of the United States is hereby authorized to pay the expenses incurred in making this investigation, upon the presentation of the proper vouchers approved by the Commissioner of Agriculture.

The second bill, (S. 438,) was introduced by Senator Ingalls, of Kansas, and properly referred. It provides as follows:

That the Secretary of the Interior shall have authority to appoint a Board of Commissioners, and to fill all vacancies which may occur therein, on the nomination of the National Academy of Sciences, to consist of three entomologists eminent in their profession.

That the said Commissioners shall devote themselves to the investigation of those insects which are most destructive to the crops of farmers and planters, and especially of the Rocky Mountain Locust, the Chinch-bug, the Army Worm, the Cotton-worm, the Hessian fly, and other insects injurious to the great staples, corn, wheat and cotton, in order to devise successful methods for the destruction of such insects. The Commissioners shall report the results of such investigations and methods, at least once in each year, to the Secretary of the Interior, by whom the same shall be transmitted to Congress. As soon, also, as the information gathered shall enable them, the Commissioners shall compile practical instructions for the repression of the different insects referred to.

That the said Commissioners shall be appointed for the term of five years, and vacancies shall be filled for the residue of the term only, and they shall respectively receive $5,000 per annum, to be paid monthly from the date of the original appointment, and shall have clerical assistance, office room, fuel, stationery, chemicals and traveling expenses, not to exceed —— thousand dollars per annum.

The first is open to the objections that it sets no limit to the expenses of the commission, and that it leaves the appointing power with the present Commissioner of Agriculture. Even were Mr. Watts' competency to choose wisely in such a field not questionable, the

work intrusted to a commission such as that called for, is too important and serious to leave in control of any one individual. If Mr. Watts had had any due appreciation of the needs of Western agriculture, he would long ere this have taken steps to have the work performed which it is designed that such a commission shall perform, and would have asked for the proper appropriations to enable him to do so, instead of making large annual demands on Congress to enable him to run a competition with legitimate seedsmen, by establishing a gigantic National seed store, which has been instrumental in doing no small injury by disseminating noxious weeds and insects.

The second bill would far more nearly meet the requirements of the country. It restricts the time during which the commission shall exist, and limits its cost. If the blank be filled in with $10,000, which would be sufficient to cover cost of experiments and other expenses, the annual expense could not exceed, and might fall below, $25,000. It specifies more clearly the duties of the commission, and provides for the investigation of not one, but of several, of our worst insect pests. It gives us, also, the best guarantee of judicious appointments; for if the assembled judgment of such a body as the National Academy of Science—composed mainly of men now engaged in scientific work for the government, and of those who have devoted their lives to applied science—will not give us a competent commission, I know not what will.

The good that a commission properly constituted and supported might do for the country is incalculable. We have made some progress in the field of economic entomology during the past quarter of a century, and particularly during the past decade. The few entomologists that have been employed by different States have made important discoveries and recommendations, while practical men who have kept themselves informed of the knowledge recorded by these officers have not failed to apply it, and have often devised measures and schemes of great value in the warfare against insect pests. Still the State Entomologists have, for the most part, been obliged to confine their attention to investigating the habits of local pests; neither the time nor the means that have been at their command have permitted the carrying on of elaborate and expensive investigations such as those we may expect from a National Commission more generously supported. The consequence is that some of the most injurious insects, such as those mentioned in Senator Ingalls's bill, have never been fully investigated, and to this day there are important points in the history of several of them, that remain a mystery.

The species mentioned in the bill are of national importance, and

should receive due attention from the nation. Congress owes it to the farmers of the country, and especially to those of the West, who are in actual need of all the encouragement and aid that can be given to them, that some effort be made to relieve them, as far as it is in human power to do so, of this insect burden which is doing as much as any other to crush them.

In the case of this locust it is not merely the question of saving to the nation, in future, such vast sums of money as this insect has filched from the producers of some of the Western States (amounting during the past three years to many millions of dollars;) it is a question affecting the welfare of whole commonwealths on this side of the Mississippi, and the ultimate settlement of a vast track of country extending from the base of the Rocky Mountains eastward, to which settlement the ravages of the locust in question offer the most serious obstacle.

Yet what has Congress done? The Senate committee reported an amendment providing for the appointment of one Commissioner for one year at a salary of $4,000 and expenses, the appointment to be made by the Secretary of the Interior, the Secretary of the Smithsonian Institution and the Commissioner of Agriculture. This amendment was very much of a farce. No one denies that our agriculture forms the basis of our national prosperity. No one who has given the subject attention can deny—because the figures confront him—that we often lose upward of $200,000,000 annually from insect depredations. Yet when our producers urge that some national effort be made to relieve them wholly, or in part, it takes on this farcical shape. What the late lamented Walsh wrote ten years ago is true to-day:

"Let a man profess to have discovered some new patent powder pimperlimpimp, a single pinch of which being thrown into each corner of a field will kill every bug throughout its whole extent, and people will listen to him with attention and respect. But tell them of any simple common sense plan, based upon correct scientific principles, to check and keep within reasonable bounds the insect foes of the farmer, and they will laugh you to scorn. Probably about nine-tenths of the members of Congress and of our State Legislatures are lawyers, busying themselves principally with law and politics; and the remaining one-tenth are physicians, merchants and manufacturers, with a very small sprinkling of farmers. Is it to be expected that a crowd of men, whose heads are mostly full of such important things as cognovits and assumpsits and demurrers and torts and caucuses and conventions, should condescend to think about 'bugs'? What do they know about farmers, except that they have got votes? Or about farmers' pockets, except that most of the taxes come out of

them? What do they know or care about entomology, fancying, as most of them do, that entomologists busy themselves exclusively in collecting the greatest possible number of beautiful butterflies? Talk to them of science, and they smile in your face. They are so perpetually teased and tormented by scientific charlatans—wolves in sheep's clothing—lobbying for legislative assistance for all kinds of ridiculous impossibilities, that they have come to believe firmly that science is only another word for humbug and imposture."

I am confident that if one-hundreth part of the pecuniary damage that is annually inflicted by insects upon the farmers were inflicted, instead, upon the merchants or manufacturers, Congress would long since have given the matter most careful consideration.

What could one man, employed for one year, accomplish where the field is so wide? Our cotton growers have lost hundreds of millions of dollars through the Cotton Worm. Yet to our shame, be it said, no one knows positively, to-day, how the insect passes the Winter, for the simple reason that no extended observations have been made on the subject. One man's time for at least a year, with liberal assistance, would be required to thoroughly investigate this species, to say nothing of the others.

If there is to be National legislation in this line, let it be wise and worthy of the occasion, or let us have none at all. Let us not court failure and disappointment by weakening the power of the commission for good, and thus adding one more to the list of similar commissions that have failed and thus brought discredit on the country and on science.

Both the Ingalls and the Harvey bills were preferable to the amended one; but even the single commissioner was denied, and after debating the amended bill, as reported by the committee for one whole morning, (and those who care to follow the debate in the Congressional Record for March 7, will find rich reading,) the bill was passed in the following form:

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled. That it shall be the duty of the Commissioner of Agriculture to investigate and gather information relative to those insects which are most destructive to the crops of planters and farmers, and especially of the Rocky Mountain locust, the chinch-bug, the army-worm, the cotton-worm, the tobacco-worm, the Hessian fly, potato-bug, and other insects injurious to the great staples, wheat, corn and cotton, in order to devise successful methods for the destruction of such insects; and to make public from time to time such information and such practical instructions for the suppression of the different insects referred to.

And thus the debate ended in the fizzle of resolving that it shall be the duty of the Commissioner of Agriculture to perform certain work, which people outside the Senate have been in the habit of sup-

posing to be his duty without any such senatorial instructions; but which duty the present incumbent has failed to perform either from inability or lack of means; and which there is no reason to believe he will any better perform in the future. Let the people of the West remember that this brilliant result on the part of a body which can vote four hundred thousand dollars to protect Goverment clothing from mildew and moths (there was a job in it) but which cannot vote twenty thousand for the protection of our crops, was brought about by the persistent efforts of Senator Logan, who pretends to represent the greatest agricultural State in the Union! Other nations have found it necessary to appoint commissions for the injurious insects of national consequence, and the day will doubtless come when our Government will feel the imperative necessity of doing likewise.

To insure good results to the country, a national entomological commission should consist of at least three persons; it should have at least five years in which to perform its labors; it should have liberal support, and last, and most important of all, it should be composed of competent and experienced men—men who can combine practical experience with scientific accuracy. The services of such can only be insured by decent salaries, and their appointment guaranteed by some such combined selective power as that proposed in Senator Ingalls's bill. Whether or not the subject will be again taken up by the present Congress it is impossible to tell; but I candidly confess that I have little faith that it will receive the serious consideration at Washington that it deserves. Congress is too busy in exposing corruption and peculation to pay much attention to the wants of our insect-cursed farmers. If the annual sum asked for in Senator Ingalls's bill were to maintain some useless diplomatic service in some third-rate foreign land, there would be some chance of getting it; but as it is for the performance of important work that is to redound to the material benefit of the country for all future time, and for the promotion of our most important industry, why, I presume, it will not be granted. But while there seems to be little chance at present of getting any national legislation on this locust matter, the wisdom of State legislation has become obvious in some of the States. Wise laws for the repression of noxious insects can only be enacted where legal and scientific knowledge are combined in the framers of the laws; and it too often happens that legislative bodies show lack of the requisite knowledge of the latter kind. We had an illustration of this last year in the laws passed by several European nations prohibiting traffic in American potatoes, with a view of preventing the introduction of the Colorado Potato-beetle; whereas, as has been abundantly shown

in these reports, such a course was not the best, but one of the very poorest, so far as the object had in view was concerned. There is scarcely any possibility of the insect being imported in barreled potatoes, but there is danger of its importation in other ways. In like manner, Algiers, Italy and other south European countries have, during the past year, passed laws with a view of keeping out the Phylloxera, which laws, by being extreme, are calculated to do harm rather than good, and are founded on insufficient knowledge of the insect's habits.

Last Summer some counties in Minnesota, and particularly Le Sueur, Todd, Meeker, Brown, Sibley and Nicollett, offered bounties for the catching and destroying of locusts. The laws had the effect to measurably clean out the insects. The Kansas Legislature, at its late session, also, passed a bill for the destruction of locusts. The bill, though an important step in the right direction, is yet, to my mind, defective in one or two vital particulars. It provides that a bounty shall be paid out of the county treasury, of five dollars for the collection and destruction of every bushel of locust eggs, and sixty cents for the collection and destruction of every bushel of unfledged locusts. The original bill, introduced by Senator Halderman, made a discrimination as to the time of destruction of the unfledged locusts; and I cannot think that the change made in committee was an improvement. As several other Western States will doubtless be led to pass similar acts for protection against locust ravages, and as I sincerely hope that our own Legislature will do so next Winter, I will briefly state what I conceive should be the essential features of any act having that object.

1. *The bounty should be paid out of the State and not the County Treasury.* When any State or portion of a State is afflicted by a locust visitation, the people of the State at large should bear the burden. By a judicious State bounty system that would avert future calamity in any threatened district, the more prosperous portion of the community is made to contribute to the relief of the afflicted, and the whole community in reality gains by the operation.

2. *The bounty should be immediately available to those earning it.* When distress and want stare the people of a locust-stricken district in the face, those who work for a bounty should be able to obtain it with as little delay as possible. This result can, perhaps, best be attained by empowering the Township Trustee, or the Street Commissioner, to receive and measure the eggs or young insects, and to issue certificates setting forth the number of bushels destroyed—the certificates to be filed with the County Clerk, who should issue to the claimant another certificate, setting forth the name and residence of the holder, and the number of bushels of eggs and young locusts collected and destroyed by him. This last certificate should be taken and received by the Collector of the Revenue of the county in which the same was given, and such collector should pay the holder thereof the sum called for under the act, and be allowed pay out of the State treasury for the same.

3. *The act should, as far as possible, tend to the destruction of the Eggs.* Barring exceptional cases, where shallow plowing can be resorted to, the collecting of the eggs will be tedious. It will be safe, therefore, to offer a pretty large inducement to collect them, and \$4 to \$6 a bushel would not be too much, and would give remunerative employment to young people through the mild weather of winter and in late Fall and early Spring.

4. *After the eggs, the destruction of the newly hatched Locusts should be encouraged by the Act.* A bushel of the newly hatched insects will contain thirty or more times as many individuals as will a bushel of the pupæ, and, moreover, their destruction prevents the subsequent injury. It would be folly to pay sixty cents a bushel for them later in the season when they are nearly full-grown and have done most of the harm they are capable of doing. The price offered, therefore, should vary with the season, and while sixty or seventy-five cents should be offered in March, the price should diminish to fifty-cents in April, twenty-five cents in May and ten cents in June. In addition to the foregoing requirements of such an act, every precaution should be taken to prevent fraud and dishonesty in obtaining the bounty.

In order to get the opinions of our own farmers who had experience last Spring as to the value of a bounty, I submitted to many the following question: "Do you not think that a bounty of fifty cents a bushel, offered by the State for the young insects when they were hatching, would have given employment and means to a large number of persons who, on account of the locust ravages, were without work; and would not such a bounty have induced so general a destruction of the insects during the first fortnight of their hatching as to virtually have prevented the subsequent devastation and suffering?" Of over a hundred answers to this question, the opinions are almost unanimously affirmative. Five of the writers believe that it would have availed little last Spring, because the people had no anticipation of the subsequent ravages, but that it would work well in future; and three doubt whether any human effort would have saved their crops. The experience of Minnesota is valuable here, and the State Commissioners do not hesitate to recommend the system after the county trials, imperfect as they were, and commenced as they were in most cases, too late in the season. It was clearly shown that in one township \$30,000 worth of crops was saved by an expenditure of \$6,000. Nicollet county paid \$25,053.00 for 25.053 bushels of locusts, but the price paid by other counties was higher: in fact, much too high. The prices I have suggested are all sufficient; for we must not forget that aside from the bounty inducement, the people who appreciate the situation must feel that they are working for self-protection, and know that it is folly to waste labor in any other way. A law such as I have suggested, once enacted and on our Statute books, might not be called into operation for many years; but would beyond all doubt serve an admirable purpose in the event of a repetition of the

evils of 1874 and 1875. Under its provisions, I am confident that in the event of another invasion, during the milder months of Fall and Spring, between the laying and hatching periods, thousands of bushels of eggs will be collected. Suppose $50,000 or $100,000 had thus been taken out of the State treasury last Winter or Spring in the way of bounties. The money would have been well earned and distributed among those who most needed it. The injury done later in the Spring would have been measurably or entirely averted, for every bushel of eggs is equivalent to the future destruction of at least 300 acres of any young crop, and each county comprises on an average not much over 300,000 acres. The smaller bounty for the young hoppers would have worked just as beneficially. It would have given employment to thousands who had nothing to do, and stayed the excuse for raiding which idlers and desperate characters made. Wherever private parties offered even a bounty of 50 cents per bushel for these young, they soon had to desist on account of the numbers brought them; which shows how effectual a State bounty would have been.

In the more thinly settled parts of the country to the west of us, a State bounty system may be more or less ineffectual, so far as the general destruction of the insects is concerned, though it will even there be one of the best means of relieving destitution; but in our more settled counties it will accomplish both ends.

SUGGESTIONS.

As a means of assisting farmers in the destruction of the unfledged locusts by trenches and in other ways I would also urge the employment of military force, a large amount of which, in times of peace, could be ordered into the field at short notice. As stated in my paper read at Detroit: "To many, the idea of employing soldiers to assist the agriculturist in battling with this pest, may seem farcical enough, but though the men might not find glory in the fight, the war—unlike most other wars — could only be fraught with good consequences to mankind. In Algeria the custom prevails of sending the soldiers against these insects. While in the south of France last summer, I found to my great satisfaction, that at Arles, Bouche du Rhone, where the unfledged locusts (*Caloptenus Italicus*, a species closely allied to our Rocky Mountain locust), were doing great harm, the soldiers had been sent in force to do battle with them, and were then and there waging a vigorous war against the tiny foes. A few regiments armed with no more deadly weapons than the common spade, sent out to the suffering parts of Missouri, Kansas and Nebraska last Spring, might in a few weeks have measurably routed this pygmean army, and materially assisted the farmer in his ditching operations.

"Hogs and poultry of every description delight to feed on the young hoppers and will flourish where these abound when nothing else does. It will be well, in the event of a future invasion, for the people in the invaded districts to provide themselves with as large a quantity as possible of this stock. Where no general and systematic efforts were made to destroy either the eggs or the young locusts, and it is found that, as Spring opens, these young hatch out in threatening numbers, the intelligent farmer will delay the planting of everything that cannot be protected by ditching, until the very last moment, or till toward the end of June—using his team and time solely in the preparation of his land. In this way he will not only save his seed and the labor of planting, and, perhaps, replanting, but he will materially assist in weakening the devouring armies. Men planted last Spring, and worked with a will and energy born of necessity, only to see their crops finally taken, their seed gone, and their teams and themselves worn out. The locusts finally destroyed every green thing, until, finding nothing more, they began to fall upon each other and to perish. This critical period in their history would have been brought about much earlier if they had not had the cultivated crops to feed upon; and if by concert of action this system of non-planting could at first have been adopted over large areas, the insects would have been much sooner starved out and obliged to congregate in the pastures, prairies and timber. Moreover, the time required for early planting and cultivation, if devoted to destroying the insects after the bulk of them hatch out toward the end of April, would virtually annihilate them. The multiplication of any species of animal beyond the power of the country to support it, inevitably proves the destruction of that species unless it is able to migrate. Let fifty batches of Canker-worm eggs hatch out on a single, somewhat isolated apple tree, and not one worm will survive long enough to mature. The leaves of the tree will be devoured before the worms are half grown, and the latter must then inevitably perish; whereas, if only a dozen batches of eggs had hatched on that tree, the worms might all have lived and matured. In the same way the young locusts inevitably perish whenever they are so numerous as to devour every green thing before they become fledged; and under certain circumstances, the sooner such a condition of things is brought about the better." The greatest generals and mightiest armies must yield to starvation!

Too much stress cannot be laid on the advantage of coöperation and concert of action, to accomplish which ought not to be difficult, with our present Grange system. One of my correspondents, Mr. Jas. E. Gladish, of Aulsville, Lafayette Co., suggests that, to insure concert

of action the supervisors of each school district be authorized to call out every able-bodied man and oblige him to work in a general system of destruction as soon as the young insects commence to travel.

In this connection it is also very obvious that our Signal Service might be made the means of giving important assistance to the farmers of the West, by warning them of coming danger. If, as I believe, the disastrous swarms which reach our State come from the extreme northwest, there is no reason why, by increasing the number of signal stations in that region the movements of large swarms should not be daily recorded, and the farmers to the east and southeast be apprised of their probable coming for weeks in advance. The people might not, it is true, greatly benefit by the information, except in preparing and providing for the possible contingency; but by thus recording the movements of swarms we shall in a few years come to know more about the native breeding places and habits of the species, and as the Bureau perfects its work, we may, through it, learn the Fall before, when the insects have become unduly multiplied or have laid enormous quantities of eggs over large areas in their native habitat, and when, in consequence, an invasion the following year is probable: in which event a larger proportion of small grains and other crops that escape the ravages of the Fall swarms can be planted in the threatened country.

The same plan of allowing the grass to remain unburned until the young hatch in Spring, suggested for the destruction of the insect in its native home, will of course work equally well when the eggs are laid in the country to the east and in our own counties.

As to the best means of disposing of the slaughtered locusts, the easiest and generally employed are burning and burying. Yet the insects might be turned to good advantage as manure, or sun-dried and preserved in cakes to feed to hogs, poultry, etc., and where large quantities are destroyed under a bounty system, some such means of making the most of them should be considered.

Finally, much can be done to avert the evil we recently suffered from, by a judicious choice of crops; but I will consider this matter under the head of

LESSONS OF THE YEAR.

There is nothing surer than that the destitution in our western counties last Spring was as much, if not more, owing to the previous ravages of the Chinch Bug than to those of this locust.

The Chinch Bug is an annual and increasing trouble; the locust only a periodical one. Now, the counties ravaged are among the richest agricultural counties in the State, and, for that matter, can

scarcely be surpassed in the country. Consisting of high, rolling prairie, interspersed, as a rule, with an abundance of good timber, these counties produce a very large amount of corn and stock. Of cultivated crops, corn is the staple, and, with a most generous soil it has become the fashion to plant and cultivate little else, year after year, on the same ground. The corn fields alternate more or less with pastures, and there is just enough small grain to breed and nourish the first brood of chinch bugs which pass into the corn at harvest time and scatter over the country, by breeding and harboring in the corn fields. Not to mention the different means to be employed in counteracting the ravages of this insect a diversified agriculture is undoubtedly one of the most effectual. It must necessarily follow that the more extensive any given crop is cultivated to the exclusion of other crops, the more will the peculiar insects which depredate upon it become unduly and injuriously abundant. The chinch bug is confined in its depredations to the grasses and cereals. Alternate your timothy, wheat, barley, corn, etc., upon which it flourishes, with any of the numerous crops on which it cannot flourish, and you very materially affect its power for harm. A crop of corn or wheat grown on a piece of land entirely free from chinch bugs will not suffer to the same extent as a crop grown on land where the insects have been breeding and harboring. This fact is becoming partially recognized, and already hemp, flax and castor beans are to some extent cultivated in the counties mentioned. But there are many other valuable root and forage plants that may yet be introduced and grown as field crops; and if the late calamities only awaken the farmers of that country to a full realization of the importance of greater diversification in their culture, the lesson will not be too dearly bought.

Of root crops that would escape the ravages of the winged insects, and which would grow in ordinary seasons, and furnish excellent food for stock may be mentioned turnips, ruta bagas, mangel wurzel, carrots (especially the large Belgian), parsnips and beets. Of tubers that are not as profitable but of which it would be well to plant small quantities in locust districts, for the reason, as my friend A. S. Fuller suggests, that they grow with such ease, and are less likely to be injured by the insects, the Chinese Yam, Jerusalem Artichoke (*Helianthus tuberosus*), and the Chufa (*Cyperus esculentus*) are worthy of trial.

LOCUSTS AS FOOD FOR MAN.

As considerable merriment was made of certain trials made by myself and others to ascertain the value of the young locusts as food,

I give here a paper on the subject, read by me before the last meeting of the American Association for the Advancement of Science:

In the few words I have to communicate under this head, it is not my purpose to inflict a long dissertation on edible insects. The subject has been sufficiently treated of by various authors, and especially by Kirby and Spence in their admirable Introduction to Entomology; while, within the year, Mr. W. R. Gerard has brought together most of the facts in a paper entitled "Entomophagy," read before the Poughkeepsie Society of Natural History. It is my desire, rather, to demonstrate the availability of locusts as food for man, and their value, as such, whenever, as not unfrequently happens, they deprive him of all other sources of nourishment.

With the exception of locusts, most other insects that have been used as food for man, are obtained in small quantities, and their use is more a matter of curiosity than of interest. They have been employed either by exceptional individuals with perverted tastes, or else as dainty tit-bits to tickle some abnormal and epicurean palate. Not so with locusts, which have, from time immemorial, formed a staple article of diet with many peoples, and are used to-day in large quantities in many parts of the globe.

Any one at all familiar with the treasures on exhibition at the British Museum, must have noticed among its Nineveh sculptures, one in which are represented men carrying different kinds of meat to some festival, and among them some who carry long sticks to which are tied locusts—thus indicating that in those early days, represented by the sculpture, locusts were sufficiently esteemed to make part of a public feast. They are counted among the "clean meats" in Leviticus (xi, 22), and are referred to in other parts of the Bible, as food for man. In most parts of Europe, Asia, and Africa, subject to locust ravages, these insects have been, and are yet, extensively used as food. Herodotus mentions a tribe of Æthiopians "which fed on locusts which came in swarms from the southern and unknown districts," and Livingstone has made us familiar with the fact that the locust-feeding custom prevails among many African tribes. Indeed, some tribes have been called *Acridophagi*, from the almost exclusive preference they give to this diet. We have it from Pliny that locusts were in high esteem among the Parthians, and the records of their use in ancient times, as food, in southern Europe and Asia, are abundant. This use continues in those parts of the world to the present day.

In Morocco, as I am informed by one (Mr. Trovey Blackmore, of London) who has spent some time in that country, they do more or less damage every year, and are used extensively for food whenever they abound so as to diminish the ordinary food-supply; while they are habitually roasted for eating and brought into Tangier and other towns by the country people and sold in the market places and on the streets. The Jews, who form a large proportion of the population, collect the females only for this purpose—having an idea that the male is unclean, but that under the body of the female there are some Hebrew characters which make them lawful food. In reality there are, under the thorax, certain dark markings—the species used, and which is so injurious to crops, being the *Acridium perigrinum*. Radoszkowski, President of the Russian Entomological Society, tells me that they are also, to this day, extensively used as food in southern Russia; while many of our North American Indian tribes, and notably the Snake and Digger Indians of California, are known to feed upon them. No further evidence need be cited to prove the present extensive use of these insects as articles of food. Let us then briefly consider the nature of this locust food, and the different methods of preparing it.

The records show us that in ancient times these insects were cooked in a variety of ways. *Œdipoda migratoria* and *Acridium perigrinum*, which are the more common devastating locusts of the "Old World," are both of large size, and they are generally prepared by first detaching the legs and wings. The bodies are then either boiled, roasted, stewed, fried or broiled. The Romans are said to have used them by carefully roasting them to a bright golden yellow. At the present day, in most parts of Africa, and especially in Russia, they are either salted or smoked like red herrings. Chenier, in his account of the Empire of Morocco (London, 1788), says that thus cured, they are brought into the market in prodigious quantities, but that they have "an oily and rancid taste, which habit only can render agreeable." The Moors use them, to the present day, in the manner described by Jackson in his "Travels in Morocco," viz.: by first boiling and then frying them; but the Jews, in that country—more provident than the Moors—salt them and keep them for using with the dish called *Dafina*, which forms the Saturday's dinner of the Jewish population. The dish is made by placing meat, fish, eggs, tomatoes—in fact almost anything edible—in a jar which is placed in the oven on Friday night, and taken out hot on the Sabbath, so that the people get a hot meal without the sin of lighting a fire on that day. In the Abbé Godard's "*Description et Histoire de Maroc*" (Paris, 1860), he tells us that "they are placed in bags, salted, and either baked or boiled. They are then dried on the terraced roofs of the houses. Fried in oil they are not bad." /Some of our Indians collect locusts by lighting fires in the direct path of the devouring swarms. In roasting, the wings and legs crisp up and are separated; the bodies are then eaten fresh or dried in hot ashes and put away for future use. Our Digger Indians roast them, and grind or pound them to a kind of flour, which they mix with pounded acorns, or with different kinds of berries, make into cakes and dry in the sun for future use.

The species employed by the ancients were doubtless the same as those employed at the present day in the East, viz.: the two already mentioned, and, to a less degree, the smaller *Caloptenus Italicus*. We have no records of any extended use of our own Rocky Mountain species (*Caloptenus spretus*), unless—which is not improbable—the species employed by the Indians on the Pacific coast should prove to be the same, or a geographical race of the same.

It had long been a desire with me to test the value of this species (*spretus*) as food, and I did not lose the opportunity to gratify that desire, which the recent locust invasion into some of the Mississippi Valley States offered. I knew well enough that the attempt would provoke to ridicule and mirth, or even disgust, the vast majority of our people, unaccustomed to anything of the sort, and associating with the word insect or "bug" everything horrid and repulsive. Yet I was governed by weightier reasons than mere curiosity; for many a family in Kansas and Nebraska was last year brought to the brink of the grave by sheer lack of food, while the St. Louis papers reported cases of actual death from starvation in some sections of Missouri, where the insects abounded and ate up every green thing the past Spring.

Whenever the occasion presented I partook of locusts prepared in different ways, and, one day, ate of no other kind of food, and must have consumed, in one form and another, the substance of several thousand half-grown locusts. Commencing the experiments with some misgivings, and fully expecting to have to overcome disagreeable flavor, I was soon most agreeably surprised to find that the insects were quite palatable, in whatever way prepared. The flavor of the raw locust is most strong and disagreeable, but that of the cooked insects is agreeable. and sufficiently mild to be easily neutralized by anything with which they may be mixed, and to admit of easy disguise, according to taste or fancy. But the great point I would make in their favor is that

they need no elaborate preparation or seasoning. They require no disguise, and herein lies their value in exceptional emergencies; for when people are driven to the point of starvation by these ravenous pests, it follows that all other food is either very scarce or unattainable. A broth, made by boiling the unfledged *Calopteni* for two hours in the proper quantity of water, and seasoned with nothing in the world but pepper and salt, is quite palatable, and can scarcely be distinguished from beef broth, though it has a slight flavor peculiar to it and not easily described. The addition of a little butter improves it, and the flavor can, of course, be modified with mint, sage and other spices, *ad libitum*. Fried or roasted in nothing but their own oil, with the addition of a little salt, and they are by no means unpleasant eating, and have quite a nutty flavor. In fact, it is a flavor, like most peculiar and not unpleasant flavors, that one can soon learn, to get fond of. Prepared in this manner, ground and compressed, they would doubtless keep for a long time. Yet their consumption in large quantities in this form would not, I think, prove as wholesome as when made into soup or broth; for I found the chitinous covering and the corneous parts—especially the spines on the tibiæ—dry and chippy, and somewhat irritating to the throat. This objection would not apply, with the same force, to the mature individuals, especially of larger species, where the heads, legs and wings are carefully separated before cooking; and, in fact, some of the mature insects prepared in this way, then boiled and afterward stewed with a few vegetables, and a little butter, pepper, salt and vinegar, made an excellent fricassee.

Lest it be presumed that these opinions result from an unnatural palate, or from mere individual taste, let me add that I took pains to get the opinions of many other persons. Indeed, I shall not soon forget the experience of my first culinary effort in this line—so fraught with fun and so forcibly illustrating the power of example in overcoming prejudice. This attempt was made at an hotel. At first it was impossible to get any assistance from the followers of the *ars coquinaria*. They could not more flatly have refused to touch, taste or handle, had it been a question of cooking vipers. Nor love nor money could induce them to do either, and in this respect the folks of the kitchen were all alike, without distinction of color. There was no other recourse than to turn cook myself, and operations once commenced, the interest and aid of a brother naturalist and two intelligent ladies were soon enlisted. It was most amusing to note how, as the rather savory and pleasant odor went up from the cooking dishes, the expression of horror and disgust gradually vanished from the faces of the curious lookers-on, and how, at last, the head cook—a stout and jolly negress—took part in the operations; how, when the different dishes were neatly served upon the table and were freely partaken of with evident relish and many expressions of surprise and satisfaction by the ladies and gentlemen interested, this same cook was actually induced to try them and soon grew eloquent in their favor; how, finally, a prominent banker, as also one of the editors of the town joined in the meal. The soup soon vanished and banished silly prejudice; then cakes with batter enough to hold the locusts together disappeared and were pronounced good; then baked locusts with or without condiments; and when the meal was completed with dessert of baked locusts and honey *a la* John the Baptist, the opinion was unanimous that that distinguished prophet no longer deserved our sympathy, and that he had not fared badly on his diet in the wilderness. Prof. H. H. Straight, at the time connected with the Warrensburg, (Mo.) Normal School, who made some experiments for me in this line, wrote: "We boiled them rather slowly for three or four hours, seasoned the fluid with a little butter, salt and pepper and it made an *excellent* soup, *actually*; would like to have it even in prosperous times. Mrs. Johonnot, who is sick and Prof. Johonnot pronounced it excellent."

I sent a bushel of the scalded insects to Mr. Jno. Bonnet, one of the oldest and best known caterers of St. Louis. Master of the mysteries of the cuisine, he made a

soup which was really delicious, and was so pronounced by dozens of prominent St. Louisans who tried it. Shaw, in his *Travels in Barbary*, (Oxford, England, 1738), in which two pages are devoted to a description of the ravages of locusts, mentions that they are sprinkled with salt and fried, when they taste like crawfish; and Mr. Bonnet declared this locust soup reminded him of nothing so much as crawfish bisque, which is so highly esteemed by connoisseurs. He also declared that he would gladly have it on his bill of fare every day if he could get the insects. His method of preparation was to boil on a brisk fire, having previously seasoned them with salt, pepper and grated nutmeg, the whole being occasionally stirred. When cooked they are pounded in a mortar with bread fried brown, or a puree of rice. They are then replaced in the saucepan and thickened to a broth by placing on a warm part of the stove, but not allowed to boil. For use, the broth is passed through a strainer and a few croutons are added. I have had a small box of fried ones with me for the past two months, and they have been tasted by numerous persons, including the members of the London Entomological Society and of the *Societé Entomologique de France*. Without exception they have been pronounced far better than was expected, and those fried in their own oil with a little salt are yet good and fresh; others fried in butter have become slightly rancid—a fault of the butter. Mr. C. Horne, F. Z. S., writing to *Science Gossip* about swarms of locusts which visited parts of India in 1863, says: "In the evening I had asked two gentlemen to dinner and gave them a curry and croquet of locusts. They passed for Cabul shrimps, which in flavor they very much resembled, but the cook having inadvertently left a hind leg in a croquet, they were found out, to the infinite disgust of one of the party and the amusement of the other."

This testimony as to the past and present use of locusts as human food might be multiplied almost indefinitely, and I hope I have said enough to prove that the nature of that food is by no means disagreeable. In short, not to waste the time of the association in further details, I can safely assert, from my own personal experience, that our Rocky Mountain locust is more palatable when cooked than some animals that we use upon our table. I mention the species more particularly, because the flavor will doubtless differ according to the species or even according to the nature of the vegetation the insects were nourished on. I have made no chemical analysis of this locust food, but that it is highly nourishing may be gathered from the fact that all animals fed upon the insects thrive when these are abundant; and the further fact that our locust-eating Indians, and all other locust-eating people, grow fat upon them.

Locusts will hardly come into general use for food except where they are annually abundant, and our western farmers who occasionally suffer from them will not easily be brought to a due appreciation of them for this purpose. Prejudiced against them, fighting to overcome them, killing them in large quantities, until the stench from their decomposing bodies becomes at times most offensive—they find little that is attractive in the pests. For these reasons, as long as other food is attainable, the locust will be apt to be rejected by most persons. Yet the fact remains that they do make very good food. When freshly caught in large quantities, the mangled mass presents a not very appetizing appearance, and emits a rather strong and not over pleasant odor; but rinsed and scalded, they turn a brownish red, look much more inviting, and give no disagreeable smell.

The experiments here recorded have given rise to many sensational newspaper paragraphs, and I consider the matter of sufficient importance to record the actual facts, which are here given for the first time.

Like or dislike of many kinds of food are very much matters of individual taste or national custom. Every nation has some special and favorite dish which the people of other nations will scarcely touch, while the very animal that is highly esteemed in

one part of the country is not unfrequently rejected as poisonous in another section. We use many things to-day that were considered worthless or even poisonous by our forefathers. Prejudice wields a most powerful influence in all our actions. It is said that the Irish during the famine of 1857, would rather starve than eat our corn bread; and if what I have here written shall, in the future, induce some of our Western people to profit by the hint, and avoid suffering from hunger or actual starvation, I shall not have written in vain.

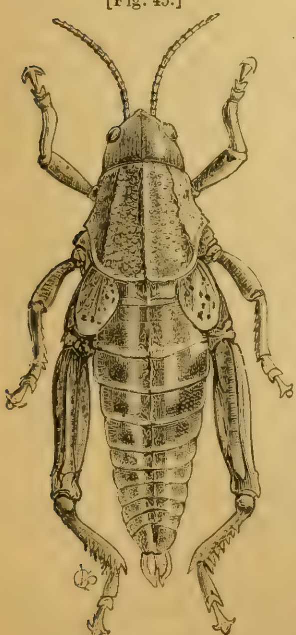
FALSE OPINIONS AND PREDICTIONS.

I have already alluded to the fact that the idea entertained by some people, and particularly promulgated by Mr. Z. S. Ragan, viz.: that our Rocky Mountain Locust comes originally from Asia, *via* Behrings Strait, has no foundation whatever in fact (*ante*, p. 118;) and under this head I desire to reassert and affirm that the belief that the species will continue to move eastward, is just as unfounded. This last belief is more generally entertained than the other, and the following from an editorial in the *St. Louis Republican* of May 25, 1875, is an example of the many expressions of it:

> As near as can be judged from the observations of last year, the grasshoppers do not move more than one hundred and fifty miles during the season. That is to say the hatching locality this year is about one hundred and fifty miles to the eastward of last year's hatching place on an average, and those who have observed their habits think that they will move across the continent at this rate, keeping within a belt of territory bounded generally by the 37th parallel on the south and the 41st on the north. If this theory be correct, they will hatch next year in the counties immediately west of the meridian of St. Louis; the next in the eastern counties of Illinois, the next on the western borders of Ohio and so on.

UNNECESSARY ALARM CAUSED BY OTHER SPECIES.

[Fig. 45.]



THE CLUMSY LOCUST.

The sense of apprehension of further danger is great in a community that has suffered severely from disaster whatsoever, and locusts which under ordinary circumstances would attract no attention were quite frequently looked upon with alarm and suspicion during the year. Mr. E. W. Kruze, of Sedalia, sent me a very large, short-winged locust found in his locality last Fall, with an inquiry as to its name, and whether there was any connection between its appearance and the late invasion of *spretus*. The same species was also sent from the same locality by Mr. Geo. Husmann. It is the *Brachypeplus magnus* of entomologists, and may be popularly called the Clumsy Locust. It is one of our largest and clumsiest species, incapable of flight, and never doing serious injury. It is common on the plains of west Kansas and Colorado, but has

never been reported from Missouri till the present year. It is prettily marked as in Fig. 45, and occurs in two distinct varieties, one in which a bright yellowish-green prevails, and the other in which pale-brown predominates. There can be no connection between its appearance and that of *spretus*, other than that the exodus of this last rendered more conspicuous, all large insects of this kind that were left behind. Reports were circulated and published last February that "the grasshoppers had appeared again at Independence, and in other parts of the State." The following letter from Dr. B. F. Dunkley, of Dunksburg, Pettis county, will show how easily people are misled:

Inclosed please find some young locusts, just hatched out. We believe them to be the Rocky Mountain locusts, but send them to you to decide. Please answer. In my report, in answer to your circular, I said that some of the locusts that hatched out late and only grew to half the size of others that migrated and left us last July, did lay their eggs, for myself and others saw them at it. Now I think these are from the eggs laid by them. If so, will the cold, when it comes, kill them?

All opinions like those expressed by Mr. Dunkley are based on "mistaken identity." The species noticed hopping about, during the mild weather of January and February, are native species that are with us all the time, and habitually hibernate in the half-grown, unfledged condition. The most common of them, and that sent by Mr. Dunkley and other correspondents, is the Green-striped Locust (*Tragocephala viridifasciata*,) a very common species, ranging from Maine to Florida, and from the Atlantic to Nebraska. It passes the winter in the immature condition, sheltering in meadows and in tufts of grass, and becoming active whenever the weather is mild. It is sometimes found in Winter in the early larva stages but more often in the pupa state, and becomes fledged toward the end of April.

[Fig. 46.]

GREEN-STRIPED LOCUST:—*a*, larva; *b*, perfect insect.

It differs generically from the Rocky Mountain Locust, which hibernates in the egg state. This Green-striped Locust, as its name implies, has, when mature, a broad green stripe on the front wings, and in the narrower, humped and keeled thorax or fore-body, (Fig. 46) may at once be distinguished from the dreaded Rocky Mountain pest. Like so many other species of its family it occurs in two well marked varieties, one in which, in addition to the stripe on the front-wings, the whole body and hind thighs, above, are pea-green; the other in which this color gives way to pale-brown. In both varieties the hind wings are smoky with the basal third greenish.

The species noticed by Mr. Dunkley to hatch out late and to lay eggs in the Fall was more probably *femur-rubrum* than *spretus*.

The species of the genus *Tettix* also hibernate in the half-grown and sometimes in the full grown condition, and are frequently supposed to be the young of *spretus*. These insects are very active, and are at once distinguished by the small head, great breadth across the middle of the pro-thorax which extends to a tapering point to or beyond the tip of the abdomen; by the front of the breast forming a projection like a stock-cravat into which to receive the lower part of the head, and by the short, rudimentary, scale-like front wings. They fly with a buzzing noise like a flesh-fly. Our most common species (*Tettix granulata* Scudder, Fig. 47,) may be called the Granulated Grouse-locust. It is like the other species, very variable in color and ornamentation, the prevailing hue being dark-brown beneath and paler above. A well marked variety has a small, pale spot on the rudimentary front wings, and a larger conspicuous one on top of the hind thighs.

[Fig. 47.]

GRANULATED GROUSE LOCUST.

Even insects belonging to a different Order were not unfrequently the cause of unnecessary alarm. In the Spring of 1875 the meadows were reported as being destroyed around Champaign and Jacksonville, Illinois, by what was supposed to be the young of *spretus*; but specimens of these supposed locusts, sent me by Chapin & Simmons, of the *Jacksonville Journal*, proved to be little Jassoid leaf-hoppers allied to the common grape-leaf hopper—insects belonging to a different order (Hemiptera) to that which includes the locusts (Orthoptera.) They were indeed *grass-hoppers*, in the sense of hopping about among the grass, but they were not the so-called grasshoppers (locusts) that were proving such a plague in parts of Kansas and Missouri at the time.

INJURIES OF NATIVE SPECIES IN 1875.

The native species of the genus to which the Rocky Mountain Locust belongs were unusually common and destructive toward Autumn in most parts of the State, except in the region ravaged by that species in the Spring. The Two-striped (Rep. 7, Fig. 34), the Differential (*ibid*, Fig. 33), the Red-legged, (*ibid*, Fig. 26), and the Atlantic species were abundant everywhere, and the two latter were more particularly injurious. These were often supposed to be the genuine *spretus*, and the reports of this last in Jefferson, Franklin and Moniteau counties in the Monthly Report of the Department of Agriculture for November and December, undoubtedly refer to them, and are a sample of the reliability of much of the entomological information that comes through that channel. They were troublesome not only in the Mississippi Valley, but in the East, for I know that they

did great damage to oats and meadows in Southwest Pennsylvania, and the following items doubtless refer to the same species, and will show how injurious they were in Massachusetts:

GRASSHOPPERS IN BOSTON.—We did not anticipate that Boston proper would ever be inconvenienced by the pests which have proved so destructive out West, but it is a fact that grasshoppers are so numerous at the South End that they destroy the flowers in the back yards to such an extent that hens are hired or bought to clear the premises and save the ornamental plants which adorn the premises. These insects are not of the Western pattern, but are native productions. If their ravages continue, it is possible some of our Western friends will be called upon to raise subscriptions for the relief of the floriculturists of Boston.—[*Boston Journal*.

I venture to ask your advice in a grasshopper matter. Three years ago a party of farmers and others in this commonwealth, tired of granite hills, gravel banks and sand flats, and wishing some little latent fertility in the original soil—combined to effect, and did effect, the reclamation from the sea of about 1400 acres of what originally was 'salt marsh.' We are amply satisfied of the fertility of this land, and so far, all is good. Last summer, however, this land and adjoining territory was scourged with a plague of locusts or grasshoppers. Whether they came in such numbers owing to the diking of these 1400 acres, or whether they would, last year, have come in equal numbers whether the marsh was diked or not, we cannot say. Our question is this, and is at the same time the point upon which we pray your advice: Can we do anything to diminish the number of these pests for next year? We could, for example, flood this whole tract of land until early spring. Would this be advisable? Any points you would be kind enough to give us on the matter, would be thankfully received.—[Letter from C. Herschel, Boston, Mass., latter part of October.

LOCUST FLIGHTS IN ILLINOIS IN 1875.

The manner in which some writers have clung to the idea that the Rocky Mountain Locust must overrun Missouri, Illinois, and the States to the East, in spite of opposing facts, can only be accounted for by inordinate love of magnifying possible danger and of making as much of a sensation as possible out of any misfortune that befalls a community. A certain amount of apprehension is pardonable; and that, under such apprehension, all sorts of insects, some of them, as I have just shown, having no relation to locusts, should be mistaken for the Rocky Mountain pest, is natural with persons who have had no acquaintance with it, and are unfamiliar with its appearance. Last September many prominent papers of the West gave the news that the dreaded swarms had finally come into Illinois. In point of fact large swarms of locusts did pass over the central portion of that State early in September, and more particularly over parts of Livingston, McLean, Vermillion, Ford, and Champaign counties. Small and scattered flights were also seen later in the month. Some writers jumped to the conclusion that said swarms were of the Rocky Mountain species, without, however, giving a particle of proof. There is nothing absolutely impossible in the occurrence of scattering swarms of the genuine *spretus* in Illinois the year following a general invasion such as we had in 1874, for while I have expressed the opinion that the species will never do any damage east of the 94th Meridian, I have admitted that it may temporarily extend to some distance beyond

that line (7th Rep., 165). But we had no reports of swarms passing over the country to the Northwest or the northwest part of Illinois, prior to their occurrence in the middle counties, and I felt so confident that the swarms were composed of indigenous species, that I so stated my belief in the Chicago *Evening Journal* of September 9th, and expressed the opinion that they had originated within the borders of the State; that there was no occasion for alarm, and that they would scarcely be heard of after they settled. These opinions were subsequently justified by the facts; for after taking every pains to ascertain the truth, all specimens from such flights examined by competent persons proved to be indigenous species. We heard nothing of their ravages or of their rising again and passing over the country to the south or east. Moreover, their flight seems to have been irregular and poorly sustained. Mr. H. P. Beach, County Judge of Ford county, Ills., in sending me specimens, writes, September 15:

> About ten days ago myriads of grasshoppers flew southward over town. Many of them came down evidently unable to keep up the journey. They seemed to be all the way from a hundred feet, to a quarter or half a mile high, or perhaps very much higher. In looking up towards the sun—the only way they could be seen,—the appearance was much like that of a snow-storm looked at in the same way. We have not heard from them since, and of course can give you no idea from "whence they cometh and whither they goeth."

Mr. B. F. Johnson, the Champaign (Ills.) correspondent of the *Country Gentleman*, and who has most persisted in believing the swarms to have been composed of the Rocky Mountain species,* also in speaking of these flights, writes to that paper (Sept. 16):

> When first seen their movements and motions were so unlike what I had conceived their flights to be, that it was not till several disabled or partially exhausted insects had been caught, and their identity with the Kansas species demonstrated, that I was convinced of their true character. I had supposed that these creatures flew in a manner as pigeons and ducks and geese do—straight ahead in a given direction and with a purpose. On the contrary, every insect seemed to be out on a holiday and acting independently of all the others. While the vast mass slowly moved south with an inclination toward the east, there was a constant circular movement of a vast majority of the whole number of individuals. * * * When it got noised abroad that they were flying, the fact produced a startling sensation. Would they increase in numbers till the sun was darkened and then descend and devour up every green thing, and leave eggs for a progeny behind them that would repeat the disaster next summer? These fears were speedily dispelled when their numbers were seen to diminish, and when it was considered that all the grasshoppers which had passed over, did they come down could make but small impression on the ten thousand square miles of corn in Central Illinois.

Actual examination of specimens from these flying bevies over Illinois, shows them to have been composed of three species, viz: the

* *Country Gentleman,* Sept. 16, 12, Oct. 7, Nov. 11 and Nov. 25. Mr. Johnson cannot be blamed for supposing these flights to have been composed of *spretus*, since considerable experience with this last and some discriminating knowledge are necessary to distinguish it from the common indigenous species, and especially from *Atlanis*. Neither can he be praised for the manner in which he has disdained the evidence in the case; for evading the real question by poor wit (*C. G.*, Nov. 25); nor for suppressing in a controversy in which he challenged my own views, some facts and arguments which I submitted to him by private letter, in answer to his last public communications on the subject.

Red-legged, the Atlantic and the Differential locusts: in no instance was a specimen of *spretus* seen. The several specimens obtained from Ford county were all *Atlanis;* a single specimen received from Mr. H. J. Dunlap, of Champaign, was a male *femur rubrum*, while specimens taken by Prof. Burrill, of the Industrial University, at the same place, as well as others from Norwood, Mercer county, sent to Prof. Thomas, were *differentialis.* The parties capturing these specimens are not apt to fall into error, and are all positive that the specimens submitted were from the flying bevies.

From these facts it results that two species, viz: *femur-rubrum* and *differentialis*, though normally having no migratory habit, and, as I believe, incapable of extended flights, can actually assist in such flights. That the bulk of these Illinois swarms was composed, however, of *Atlanis*, scarcely admits of a doubt. The other two, less able to sustain lengthened flight, would naturally be most near the ground and most often captured; while *Atlanis*, which we now know to occur in this part of the country as well as East, and to often display the migratory habit, would fly higher.

There are two facts which it will be well to bear in mind in this connection, as explaining the above phenomena. The first is that, as we have already seen, *Atlanis* was very common in Missouri, even in fields where it had never been noticed before. It prevailed to such an extent in Illinois, that around Carbondale, Prof. Thomas could not find a single specimen of the typical *femur-rubrum*, and there was not a single specimen of it among a number which he caused to be collected for me. So obvious was this fact that Prof. Thomas was led to suggest in the Chicago *Inter-Ocean* of October 9, 1875, that the one was the out-growth of the other. I quote his language:

> This species (*femur-rubrum*) which can usually be found anywhere in the fields or along the roadside during the Summer and Fall, appears to be entirely replaced by a new form, which I take to be the one described by Prof. Riley as *Caloptenus Atlanis* which is an intermediate form between C *femur-rubrum* and *C. spretus*, so near, in fact, to the latter that it is almost impossible to distinguish the one from the other. I have searched in vain for *femur rubrum*, it seems to have entirely disappeared, and that the new variety has taken its place. Is the one the progenitor of the other: the former of the latter? I am no believer in Darwinianism, but here is presented a problem difficult to solve, unless we admit the correctness of that theory, or, that all three supposed species are but varieties of one, which I am half-way inclined to believe is the case. Otherwise how are we to account for the appearance of this new form this season? The *spretus* has not visited our section, the *femur-rubrum* is absent, and here I have before me a large number of specimens gathered here, some of them to-day, with the long wings and the notched male abdomen, corresponding exactly to Professor Riley's description of *Caloptenus Atlanis?* Is the common *femur rubrum* being transformed into *spretus*, this being the intermediate step? If so, over half the distance has already been traversed.

The second fact is, that *differentialis* was also unusually abundant. A letter from Mr. M. Brinkerhoff, of Onarga, Illinois, dated October 18,

1875, and accompanied by specimens, describes them as in great numbers there, filling the ground with their eggs.* The following which refers to the same species is also interesting:

While the migrating hopper committed such devastation west of us, we here at Bluffton have the manor-born, in immense numbers. A patch of potatoes, and some sweet corn, seemed in danger of being consumed, when a flock of purple grackles, our crow blackbird as it is usually called, came to our rescue. The few days that they have visited the patch, has thinned out the hoppers amazingly. I never before noticed that this bird was so useful in this respect, and as they are plenty, we may expect to be rid of the big grey fellows (hoppers). They are more than twice the size of the Colorado hopper, and are nearly as bad on a crop when plenty. What saved our little crop from utter destruction, was an open field of land thickly covered with wild chamomile, upon which they fairly swarmed. On this we saw them as thick as the Colorados, in Sedalia or Warrensburg.—[S. Miller, in *Rural World*, Aug. 14, 1875.

Though unusually common, yet *differentialis*, if I may judge from my own experience in our fields and around Chicago, last Fall, compared only as 1 to 50 with *Atlanis*, and it is doubtful if it formed a larger proportion of the flights. How are these exceptional migrations of local species to be explained? We know they have occurred at intervals in the East, (7th Report pp., 167–171) and we now have evidence that they may occur in any part of the country; and indeed local swarms were not confined to Illinois last Fall as they were also noticed in Kentucky. I think the explanation is simple. The excessively hot dry years of 1873 and 1874 permitted the undue multiplication of these native species, and they were already very troublesome in the latter year (7th report, p. 173.) The myriads that hatched out in 1875 were scarcely noticed at first and made little impression on the luxuriant vegetation that a wet and favorable season produced. By September, when a spell of dry weather cured the grass and the locusts had acquired full growth, we can imagine that they swarmed in much of the prairie country of Central Illinois. Whenever they abound to an unusual degree the migrating instinct is developed, just as it is under like circumstances in many other insects, as butterflies and beetles, that are normally non-migratory. The reasons we can only surmise; but aside from those of hunger, etc., previously suggested (Report 7, p. 164), the annoyance and inconvenience to which the females while attempting to oviposit, have to submit from their companions, under conditions of excessive increase, may have something to do with it. But mere increase in numbers would not give to species like *femur-rubrum* and *differentialis*, which

*The eggs of *Caloptenus differentialis* may be distinguished from those of *spretus* by the larger and more irregular size of the mass; by the greater number composing it; by the somewhat larger size of the individual egg which measures 0.19—0.22 inch in length; by the coarser reticulations of the shell, and by the brown color of the gummy fibrous matter that is intermixed with them and glues them together. The color of the egg varies from yellow to deep carneous, the latter prevailing, and the posterior or narrower end is always somewhat constricted and darker.

are ordinarily heavy-bodied and short winged, the power of extended flight, and there is little doubt, in my mind, that the same exceptionally hot, dry seasons which permit this undue multiplication, also modify the individuals, and cause a decrease in bulk and increase in wing-power. The facts support this view, for the flying specimens of *differentialis* sent to Prof. Thomas had, as he writes me, "the body lighter and the wings longer, and some of that peculiar fierce appearance belonging to migrating specimens;" and I have specimens from Kansas and Minnesota which differ so much in these respects from the more normal specimens as found with us in ordinary seasons, that they can scarcely be recognized as the same species. The casual observer knows how thoroughly plants are modified in size and habit by season and condition: the same holds true of insects, and more particularly in certain groups.

Given that over the vast prairie region of Central Illinois, the insects were as thick as I found them in many of our own fields, where every step would cause two or three hundred to rise, and let this migratory instinct be developed, and the mystery of the Illinois flights vanishes. They are exceptional local phenomena: they are neither as strong nor as long sustained as those of the Rocky Mountain species; nor are they in any sense to be as much dreaded.

In short, whenever the climate and conditions in the Mississippi Valley approach those existing in the native home of the Rocky Mountain Locust, some of our native species, and especially those nearest akin to it, also approach it in habit. If the climate of Illinois and Missouri were to permanently change in that direction, these species would become permanently modified; but as there is no immediate danger of such a contingency, the Rocky Mountain Locust is the only species, here considered, that can properly lay claim to the migratory habit.

PROSPECTS IN 1876.

The people in our western counties are very naturally quite interested in the locust prospects during the coming year; the more so that the story has been widely circulated that the danger was greater than ever before. As an example I take the following from an editorial in the St. Louis *Globe-Democrat* of the 26th of December last:

> Persons whose experience in such matters entitles their opinions to respectful consideration, declare that the Summer sun of 1876 will hatch such swarms of grasshoppers in the West as have never before been seen, and that the tract of country in which they will prevail will be wider than ever before, reaching from a long distance west of the Black Hills to the center of Missouri and Iowa.

I know of no persons whose experience deserves respectful consideration who have declared anything of the sort; and so opposed to

the facts is the declaration that I do not hesitate to state that there is no possible danger of any general injury in Missouri this Spring, and no probable danger in the Fall; and to convey my views more fully I reproduce a short article which I last January communicated to the *New York Tribune:*

Some one has announced the fact that there has been a prodigious number of locust eggs laid all over the nothwest portion of the country lying east of the Rocky Mountains. Some one has asserted that the soil of Wyoming, Montana and Dakota is generally and thickly charged with these eggs. Who this some one is with such vast experience that he has examined the soil over such large areas as to make the statement, nobody knows. But some careless editor has set the gossip's ball in motion, and it has rolled on from paper to paper, with one change and another, until at last the Boston *Journal* includes Missouri, Kansas and Nebraska in its portentous scope. "Observations show," says this journal, "that last year's grasshoppers deposited immense numbers of eggs, and when the warm weather comes and hatches them, devastation even more than these sections have previously known, will be pretty sure to follow." "Observations show" that some editors are very gullible, and too ready to propagate the sensational, and to disseminate alarming statements on the flimsiest grounds. They publish as fact the veriest *on dit*, without once inquiring into its probability or caring for the consequences.

From personal observation in parts of Missouri and Kansas, and from an extensive correspondence, I am able to say that such statements, so far as these two States are concerned, are entirely groundless; and I have every reason to believe that the same will hold true of Nebraska; while in Minnesota, the investigations of the commission appointed last summer by the Governor, indicate that even where eggs were laid in that State, they mostly perished from excess of moisture, which dissolved the glutinous substance which normally protects and holds them together. That in some parts of the high country lying east of the mountains, especially toward the North, eggs have been deposited in numbers, is not only probable but pretty certain. But in that region such is the case every year, for it is the native home of the swarms which occasionally extend to the upper Mississippi valley. But the number of eggs laid in the States of Missouri, Kansas and Nebraska by the few straggling insects that passed into that country last Fall, will not equal that laid in ordinary seasons by indigenous species. In Colorado, also, there have been in most parts such abundant rains since locust eggs were laid, and the ground has been so unusually moist, that there is some hope that the bulk of the eggs are or will be destroyed.*

I give it as my belief that, first in the three States mentioned, (Missouri, Kansas and Nebraska), there will not hatch as many locusts next Spring as would naturally hatch in ordinary seasons from the indigenous species; second, that, compared with other parts of the country, those States ravaged by locusts last Spring and early Summer will enjoy the greater immunity, during the same seasons of 1876, not only from locust injuries, but from the injuries of most other noxious insects, except the wood-borers. In short, the people of the ravaged section have reason to be hopeful rather than gloomy. They will certainly not suffer in any general way from locust injuries in the early season; and the only way in which they can suffer from the migrating pest is by fresh swarms later in the year from the far northwest, the odds being, however, from a number of reasons which it is unnecessary to enumerate here, very great against any such contingency. There is one redeeming feature in the *Journal's* article. It is the advice to the people of the States named to not be profligate of the abundant corn crop they have garnered, but to store it for an emergency. If nothing short of a false alarm would cause them to do this, the statement might find justification; but the lesson of 1875 so clearly pointed to such a course, and was so dearly bought, that it will not needlessly go unheeded.

---

*The *Colorado Farmer* for April 28, 1876, says editorially: "Hearing many conflicting reports about the probable appearance and ravages of the hoppers this season, we took time recently to visit a number of ranches on Clear Creek, Ralston and Bear creeks, and investigated for ourselves and interviewed many, and from all the inquiries we have made of reliable people from all parts of the Territory and a careful gleaning of our exchanges, we have been lead to the following conclusions:

There will be some locusts, but not in the countless millions of last year. They may do some damage, but not such havoc as in the past. They have already commenced to hatch in warm, sunny localities, and a careful examination of the ground in many places miles apart, and in different sections of the country and their favorite hatching grounds demonstrates that the eggs are in insignificant quantities compared with last near, and that where farmers have worked to exterminate them by dragging the ground several times during the Fall and early Winter and Spring, millions of eggs have been destroyed.

THE GRAPE PHYLLOXERA.

This insect still continues to attract much attention abroad as well as at home. Owing to the excessively wet summer of 1875 it did comparatively little injury in our own vineyards, and I have little to add to what has been previously published in these Reports.

COMPLETION OF ITS NATURAL HISTORY.

Having shown last year that our knowledge of the natural history of this insect was then all but completed, it gives me pleasure to now record its completion, which I can best do by supplementing with a few additional notes the following paper read last October before the St. Louis Academy of Science:

It is well known to those who have followed the habits of *Phylloxera vastatrix*, as these have been discovered and recorded, that one of the most important points in the life-history of this insect that has hitherto remained unsettled, is the nidus which the winged female chooses for the consignment of the few eggs she lays. In 1871 I ventured the supposition that these eggs were deposited in the down of the leaf-buds,* but subsequent observation led me to believe that "the more tomentose portions of the vine, such as the bud, or the base of a leaf-stem, furnish the most appropriate and desirable *nidi*" for these winged mothers, and that the eggs were also laid in minute crevices on the surface of the ground, especially around the base of the vine †—all these conclusions being based on observations made on the insects in confinement. The question is an important one practically, as the hope was entertained that, by knowing just where to look for these eggs, we might be able to check the rapid spread of the Phylloxera disease, since it is through them alone that the disease can be started in new localities distant from infested regions. Feeling, from past experience, that it was extremely difficult to solve the problem in the open vineyard, and that experiments with the insect confined in tubes were more or less unsatisfactory, I built, early in September, a tight house of heavy Swiss muslin, six feet high and four feet square, over a Clinton vine. The house was built so as not to permit even so small an insect as the winged Phylloxera to get in or out, and the vine was trimmed so that but few branches and leaves remained to be examined. Into this enclosure I brought an abundance of infested roots, and for the past five or six weeks I have been getting the winged females confined where I could watch their ways. In addition, I prepared large, wide-mouthed glass jars, by half filling with moist earth. Into the earth was then stuck a vial of water holding a tender grape-sprig with young leaves. The leaves were thus easily kept fresh and growing for a fortnight and upward. From day to day, as the winged females were obtained from other vessels prepared for the purpose with infested roots, they were introduced into these jars containing living leaves.

The results of these endeavors to supply the winged mothers as nearly as possible with the natural conditions have been satisfactory, and they prove that, as was surmised, the eggs are laid in crevices of the ground around the base of the vine, but still more often on the leaves, attached generally by one end amid the natural pubescence, or rather down, of the under surface; and while heretofore all efforts to artificially hatch

* Fourth Mo. Ent. Rep., p. 65. † Seventh Mo. Ent. Rep., p. 98.

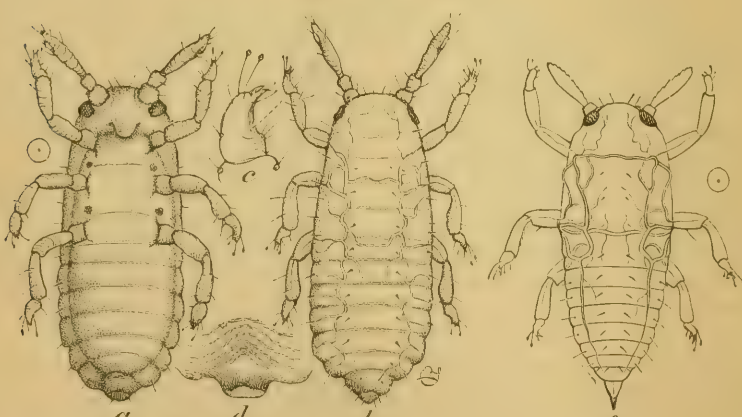
the progeny from these eggs have, for the most part, failed, I have this year succeeded in hatching them without difficulty, and present a tube with living individuals, and also mounted specimens for the inspection of members. I have also succeeded in getting both sexes of the American Oak Phylloxera and in thus completing the natural history of both species.

Though this true sexual form of *vastatrix*, from the winged and agamous female, has never before been carefully observed and described, it was nevertheless anticipated by Balbiani in his studies of the European Oak Phylloxera (*Phylloxera quercus* Fonsc.) and by myself in my studies of the American Oak species (*P. Rileyi*).* Balbiani had also obtained what is evidently the same from eggs deposited by wingless, hypogean mothers late in the season and after the winged mothers cease to fly.†

The winged females carry in the abdomen from three to five and sometimes as many as eight eggs. These eggs are of two sizes—the smaller, which produce males, about three-fourths the size of the larger, which produce females. As the whole organization of these aërial mothers—with the stout proboscis and ample wings—indicates, freedom and nourishment are needed to bring the eggs to perfection and cause their proper oviposition. In confinement in small vessels, where these requisites are not easily furnished, the eggs are generally voided, with the death of the parent, on the sides of such vessels; and those freely laid are with the greatest difficulty brought to the hatching point. Only in two instances did I succeed in doing this last year. These failures in the past find their explanation not so much in the difficulty of supplying the natural conditions, as in lack of experience as to what those conditions were.

Whether owing to the want of down on the Clinton leaf, or to the fact that the minuteness of the eggs makes it about as difficult to find them on a square four feet of earth surface as the proverbial "needle in a haystack," the eggs found on the vine in the aforementioned muslin enclosure were very few compared to the number of winged insects which must have come out of the ground. It was also next to impossible to

[Fig. 48.]



SEXED PHYLLOXERÆ:—*a*, female *vastatrix*, ventral view, showing egg through transparent skin; *b*, do, dorsal view; *c*, greatly enlarged tarsus; *d*, shrunken anal joints as they appear after oviposition; *e*, male *caryæcaulis*, dorsal view—the dots in circle indicating natural size.

* Seventh Mo. Ent. Rep., p. 119.

† *Comptes Rendus de l'Acad des Sc.*, Paris, Nov. 2, 1874.

find, and quite impossible to follow, the sexed individuals after hatching. In the prepared jars, where the tomentose leaves of *Labrusca* were kept, I obtained more satisfactory results; for, while a few eggs were laid on the surface of the ground, especially in the space between the earth and the glass, and a few others on the upper side of the leaves, by far the larger number were attached to the under surface, generally by one end and thrust between the natural down of the leaf—evidently showing that this is the natural nidus chosen. The winged mothers die soon after ovipositing, and their shrivelled and decaying bodies adhere to the leaf-down.

By taking a leaf bearing eggs that are eight or nine days old and enclosing it in a smaller, tightly corked tube, the sexed individuals hatch freely, and are easily watched. This hatching takes place on about the tenth day after deposition, with our late September temperature. The egg perceptibly enlarges during this time, a fact that might be explained by endosmosis of the leaf-juices were it not known that the same fact holds true of many soft insect eggs that are not attached to succulent leaves or other living vegetation. The red eyes are seen through the delicate egg-shell early in the development of the embryon, and just before hatching the joints of the body are perceptible. The egg-shell is so delicate that in the process of hatching it is usually pushed back in folds, and is left as a little wrinkled, whitish mass: occasionally, however, it more nearly retains its original form.

The sexed individuals are at once distinguished from all the other forms which this interesting species assumes by the obsolete mouth-parts, the sexual organs and the more highly developed nervous system: otherwise, in size, in smoothness and in obsoleteness of the basal joint of tarsus, they most closely resemble the newly hatched larva.

The female (Fig. 48, *a*, *b*) measures 0.40 mm., and is about one-third as broad. The body widens slightly behind, and the two narrow anal joints of the abdomen swell out prominently from the others. A mere swelling between the two anterior coxæ represents the mouth-parts. The antennæ more nearly resemble those of the wingless, agamous ♀ than of the winged one, having but one rather small plate near the end of the third joint, which third joint is generally constricted at base so as to give it a somewhat more pedunculate appearance than in the other forms; this does not always appear, however, as in some of my mounted specimens the diameter of the joint from base to tip is nearly uniform. The minute, black, dorsal, hair-like points, as also the dusky subventral warts each side of sternum just outside the coxæ, are visible as in the agamous ♀, but not the six pale medio-sternal tubercles between the legs. The legs have the tibiæ rather heavy terminally, and the tarsi show no distinct basal joint: they otherwise precisely resemble those of the agamous ♀, and are, together with the antennæ, similarly more dusky than the body. In most of my mounted and transparent specimens (9 examined), two irregularly contorted nervous chords with numerous finer ramifications are distinctly visible, one each side, crossing and joining on the prothorax and metathorax.

The male differs in no respect from the female, except in the bulbous penis tapering to a point; in broadening, if anything, before rather than behind, and in being about one-fourth smaller. Barring the somewhat shorter black points, he is the counterpart of the same sex in a larger species (*caryæcaulis*) which I have already illustrated and the figure of which I here introduce (Fig. 48, *e*.)

The single egg which the true female carries develops rapidly after she is born, and on the second day already occupies nearly the whole body, as shown at Fig. 48, *a*. It is delivered the third or fourth day, and this generally happens independent of impregnation.

This impregnated egg, which I have so far obtained only in my small tubes, is smooth like the other eggs of the species, but more elongated or ellipsoidal, and but very slightly broadest behind. It measures 0.32 mm., and is nearly three times as long as broad. Bright yellow when laid, it soon acquires a deeper, yellowish-green color. The posterior end is generally thickened or roughened by what is probably a mucous secretion that serves to attach it.

Where this egg is naturally laid I have not yet ascertained, but in all probability it is carried into or near the ground by the impregnated parent. The young hatching from it is the normal agamous female; for, though I have not yet hatched this impregnated egg of *vastatrix*, I have succeeded in doing so with that of *Rileyi*, and Balbiani long since did so with that of *quercus*. I am led to think that, once impregnated, the female carries her egg into the ground, because in 1873 I found females whose abdomens, instead of being filled with numerous small eggs, were distended with a single large one;* and, though I was puzzled to interpret the fact at the time, I have no doubt now that I then had under my eyes the true, impregnated female here described, and that I overlooked the obsolete mouth.

The habits of these sexed individuals, as I have been able to observe in both the Grape and American Oak species, are similar to those recorded by Balbiani of the European Oak species. The male is quite ardent, more active than the female and somewhat longer-lived.

The complete natural history of the Grape Phylloxera may now be considered established. A full biological view of the species exhibits to us no less than five different kinds of eggs: 1st, the regularly ovoid egg, 0.25 mm. long and half that in diameter, of the normal, agamic and apterous female, as it is found upon the roots; 2d, the similar, but somewhat smaller egg of the gall-inhabiting mother; 3rd, the ♀ egg from the winged mother, rather more ellipsoidal, aud 0.50 mm. long when mature; 4th, the ♂ egg from same, ¼ less in length and rather stouter; 5th, the impregnated egg, just described, 0.32 mm. long and still more ellipsoidal. We have also the singular spectacle of an egg from the winged mother increasing from 0.34 mm. (its size when laid) to 0.40 mm. (its size just before hatching;) giving birth to a perfect insect 0.40 mm. long, and this in turn, without any nourishment, laying an egg 0.32 mm. long. A being is thus born, and, without food whatsoever, lays an egg very nearly as large as that from which she came.

From observations here recorded I would draw the following conclusions:

1. We can no longer entertain the hope of any practical good from the knowledge of the nidus chosen by the winged mothers, as the destruction either of these or of their eggs—scattered as they are on the leaves all through a vineyard—is out of the question. The objects are too small to be practically searched for, and it is virtually impossible to prevent the spread of the disease in this stage. We might almost as well try to prevent mildew by the destruction of the invisible floating spores that must at times pervade the atmosphere of a vineyard. The hope entertained by Lichenstein that the winged mothers would congregate and be attracted to some particular plant must, I think, be abandoned.

2. The only preference shown in this respect would seem to be for those leaves that are most downy or tomentose; and from this view of the case we get another probable reason why the varieties of Lubrusca which are characterized by an abundant downiness on the under surface of the leaves suffer most from the insect.

3. Having already had the young from the impregnated egg of *Rileyi* hatch in about a fortnight after it was laid; having shown in previous writings that this species winters in the larva state, and not in the impregnated egg as does the European *quercus*; and, remembering, further, that *vastatrix* resembles *Rileyi* in wintering as

* One fact, which is not now interpretable, but may have a significance in future, I feel constrained to record in this connection. It is that, in examining *vastatrix*, I have occasionally met with degraded ♀'s (underground mothers) in which the abdomen, instead of containing numerous small ova, was well nigh filled with a single, much larger, egg. Every observed fact leads to others yet unknown and unsuspected; and the full history of Phylloxera has yet to be written.—6th Rep, p. 87.

larva, it is safe to conclude that the impregnated egg of *vastatrix* will also hatch the same season that it is laid, and that we cannot apply to it the term "winter egg" which Balbiani applies to the impregnated egg of *quercus*. It is not unlikely that, since a few of the winged females issue as late even as the latter part of October, some few also of the later produced impregnated eggs may pass the winter unhatched; if so, they may be considered exceptions to the rule. In the same way, a few of the more common eggs from the agamous ♀ may be exceptionally found on the roots in winter, though as a rule only the hibernal larva is found.

In conclusion, I would state that this year's studies of both *vastatrix* and *Rileyi* confirm me in the opinion, elsewhere maintained (7th Rep. p. 91), that the term "pupa," as applied to the sexed eggs by Lichtenstein, is quite unwarranted, and that the egg-covering—thin and plastic though it is—can in no sense be likened to a cocoon, and still less to a "silken cover." The fact of its shriveling up makes it none the less an egg-shell, for this shriveling process occurs in all eggs with very delicate and plastic covering, and may, indeed, be witnessed in the gall-inhabiting form of *vastatrix*, though no one has thought of questioning the ovarian nature of the eggs found in those galls.

My sincere thanks are due to Miss M. E. Murtfeldt, who has carefully carried on observations for me during my necessary absence. Without her patient watching and persevering efforts, my endeavors must have measurably failed of results.

Soon after the above paper was printed, I received one by Balbiani, published October 4,* in which he announces having also discovered the nidus which the winged females choose, and obtained the solitary impregnated egg of *vastatrix*. Lichtenstein also about the same time succeeded in obtaining the sexed individuals and the solitary egg, at Montpellier. The same observations were thus being made simultaneously by three parties, both in Europe and America. The few eggs which I obtained in my tubes became discolored and perished, perhaps from not being impregnated, and I can make little out of them under the microscope. Balbiani, by the assistance of M. Boiteau of Villegouge (Gironde) was able to make his observations in the open vineyard. He has been more fortunate and assiduous than myself in continuing them, and has, as I just learn while writing this, obtained the progeny from the impregnated egg. It is evident, also, that with his trained eyes and excellent instruments, he sees minute details which escape the notice of others, and I lay before the reader the results of his observations.

The eggs of the winged female are not only placed on the under side of the leaves amid the natural down, but also beneath the loosened bark of branch and trunk, and in the recesses afforded by the buds. As my friend Lichtenstein found them laid on muslin with which he confined winged mothers, it would seem that they may be laid almost anywhere. Nevertheless I am satisfied that the leaves

*Comptes rendus de l. Ac. d. Sc., Paris, Oct. 4, 1875.

form the most natural and most favorable nidi. Balbiani describes the impregnated egg in detail as 0.28 mm. long and 0.13 wide, and as mine were somewhat longer they probably vary slightly in size. It gradually acquires an olive green tint, speckled with minute darker dots. It is polished, translucent, and the shell is finely reticulate with hexagonal meshes. This egg is always laid on the more solid and permanent parts of the vine under the bark that is becoming loose. It remains in these positions during the winter and with the renewal of vine growth in Spring gives birth, as from analogy we knew it would do, to the wingless mother louse which starts anew the virginal reproduction. In all essential characters it is like the normal root-inhabiting, wingless, virginal mother, but is intermediate in size and form between this last and the true sexual female when compared at the moment of hatching. Balbiani gives the length as 0.42 mm. and the width 0.16 mm.

The habits of this mother which, with increased vitality starts the somewhat complicated cycle of the species' changes, have not yet been observed, but she doubtless seeks the roots to there surround herself with eggs, resting no doubt for the most part just at the butt of the vine; while an occasional individual, where the conditions are favorable, may settle on a tender leaf, and found the gall-inhabiting type.

These observations of Balbiani's establish one thing, which is, that the impregnated egg hibernates before hatching, and they would seem to indicate that the third conclusion which I drew (p. 161) is erroneous. But I yet strongly incline to believe that further observations will prove that, as there suggested, the hibernation of the impregnated eggs will prove exceptional and that they mostly hatch the same year that they are laid. The eggs which I obtained having failed, and feeling much interest in verifying in this country the interesting discoveries made by Balbiani in France, I have perseveringly sought for the impregnated egg in our own vineyards the past winter. I have most carefully examined many a vine from "top to stern" myself, and have employed Mr. Theo. Pergandy, who is well trained in the examination of minute objects, during nearly every mild day to inspect vines in vineyards in which I knew the Phylloxera to occur. I have had whole vines dug up from the Bushberg vineyards, and collected large quantities of the loose bark for careful examination and inspection in-doors; and while I have been rewarded by some interesting discoveries, and have obtained the eggs of a large number of other insects, I have failed to find the first Phylloxera egg, though in several instances I have found what may be the empty shell. This

failure to find here what has been found in France, may be due to the comparative scarcity of the insect with us in 1875, and while I would by no means conclude from it that there is any difference of habit in the insect here and there, it shows how very rare these winter eggs may sometimes be.

PRACTICAL CONSIDERATIONS GROWING OUT OF THESE LATEST DISCOVERIES.

Since the announcement that the impregnated egg winters under the loose bark, a number of French writers have proposed plans for its destruction, and urged that such was the readiest way to avert Phylloxera injuries. The plans mostly consist of the decortication of the vines and burning of the bark, and the application to the wood of some oily liquid such as kerosene, that may be applied so as to penetrate and destroy the egg and not injure the wood. While granting that the destruction of such eggs in such manner is desirable, especially in a vineyard in an infested neighborhood, but not yet suffering, I doubt whether it is sufficiently important to warrant the labor involved; for those who advocate such a preventive system most earnestly, forget that by far the larger number of the insects hibernate as young larvæ on the roots, and that according to Balbiani this same impregnated egg may be produced on the roots from sexed individuals born of hypogean, wingless mothers.

While it is always best to know the truth, in the present instance it certainly does not give us any advantage over our enemy. Now that we have obtained a full survey of his powers we find no especial weak point by attacking which he can be destroyed. He has too many resources at command. From the practical side it seems to me that the lessons taught by these late discoveries are more discouraging than otherwise. There is no chance of managing in any general way the destruction of the eggs on the leaves, and it is evident now that the insect may be imported from one country to another on cuttings as well as on rooted plants; and that winter submergence will not eradicate the pest. We furthermore get a better understanding of the fact that in so few instances the insect has been eradicated by insecticides applied to the soil. One valuable lesson is taught by these facts: it is that the season in which insecticides applied to the roots will do most good, is in the interval between the hatching of the impregnated winter egg and the appearance of the winged females, i. e., during May and June.

PHYLLOXERA RAVAGES IN CALIFORNIA.

There is no longer any doubt whatever of the occurrence of Phylloxera in California. It has during the year made its presence but too

manifest around Sonoma, and many vineyards there are already seriously affected. Mr. Julius Dresel of that place, who was in my office the past winter, informed me that he has himself had to root up many hundreds of vines, and that the roots are crowded with the lice. There naturally exists much excitement among the grape-growers of the Pacific about it. Had the subject not been thought too lightly of and had the California authorities taken some steps to guard against the introduction of the pest when I pointed out the danger in the Fall of 1871 in the *Rural New Yorker* and *Rural World*, and also in my 4th Report (p. 56), the calamity which now seems inevitable to their grape interest might have been averted. Active measures, even at this late day may do much good, but it seems impossible to get our politicians to appreciate the interests of the producing classes. A bill "for the destruction of the Phylloxera" was introduced at the last session of the Legislature which, through indifference, failed to pass; and it is probable that nothing will be done till bitter experience obliges action, by which time it will in all probability be useless. While the authorities fail to appreciate the situation, the grape-growers are much exercised, and are already endeavoring to profit as much as possible by the researches of others, and the experience of the French. This they will be able to do through the efforts of Prof. E. W. Hilgard, of the University of California, who appreciates the situation and who, in an address, delivered before the State Vinicultural Association, at San Francisco last November, gave an excellent resume of the insect's habits and of the best means of managing it. He infers that, from the great local intensity and comparatively slow spread of the disease, the winged females are not developed to the same extent as in France or the Mississippi Valley—an inference which, it is to be hoped, future experience may warrant, but which I fear it will not.

ITS OCCURRENCE IN THE SOUTHERN STATES.

While I have shown in previous Reports that the Phylloxera actually occurs in North Carolina and other Southern States, the examinations made by Messrs. Berckmans and Ravenel, at Augusta, Ga., and Aiken, S. C., which I reported last year, indicate that it is not found in those localities. In the Proceedings of the 15th Session of the American Pomological Society is a report of a special committee, consisting of A. S. Fuller, of N. J., Messrs. Berckmans and Ravenel, and Thos. Taylor, of Washington, D. C., appointed at the previous meeting of the society upon the following resolutions offered by Mr. Berckmans, and which indicate the object of the mover:

"*Whereas*, American vine-growers are accused in the south of France of having introduced there the *Phylloxera vastatrix or Gall Louse*, which is now causing the destruction of thousands of acres of vineyards, it is due to them that this assertion be removed; it is, therefore,

"*Resolved*, That a committee be appointed to fully investigate its origin, whether American or imported, the amount of destruction caused here, its area of dissemination, etc.

"The committee to report the results of their labors in the Proceedings of the present session."

The report was not submitted for discussion at Chicago, which is to be regretted, as it is a very partial and one-sided statement of the facts. It consists of some general statements by the chairman, of the examinations made in 1874 by Messrs. Berckmans and Ravenel, and published by me last year, and of additional examinations made by the same parties in the same localities in 1875, and which, as embodying the only facts in the report, I republish herewith:

Examinations made by Mr. Ravenel in 1875.

June 5th.—Made an examination to-day of 2 Isabellas, 1 Warren, and 1 black July vines, for Grape Phylloxera; found nothing.

June 11th.—Examined at Mr. Cornish's vineyard, 1 Muscat, of Alexandria, 1 Chasselas, 1 Catawba, 1 Isabella, 1 Black July, and 1 Warren; could find no traces of insect life; roots, both young and old, perfectly healthy.

June 15.—Examined the following grape-vines at Mr. Scheveiren's vineyard, situated in the lower part of Aiken, 1 Isabella, 1 Catawba, 1 Delaware, 1 Clinton, 1 Concord, 1 Riesling, and 1 Chasselas. These vines are about 8 years old, (except the last which were only 2,) healthy and vigorous, and in fine fruit; we could find no traces of insect life. The young and older roots were clean and healthy, and showed no ravages in previous years.

July 8th.—Went over to Mr. Berckmans' Fruitland Nursery, near Augusta, Georgia, and made examination of the following vines:

1 Clinton, 2 years old, under cultivation.
1 Clinton, 3 years old, under cultivation.
1 Ives, 4 years old, under cultivation.
1 Concord, 4 years old, under cultivation.
1 Taylor, 5 years old, not cultivated one year.
I could find no trace whatever of insect life.

The roots of young and old are healthy, and exhibit no effects of former ravages.

The above are transcripts from my notes taken at the time the examinations were made. In the two seasons I have examined 60 specimens, comprised in 18 different varieties of grapes, and in four separate localities. The soils of these four localities vary from a light and loose sandy soil (my own, on the borders of the "sandhill" region,) to a firmer and more compact (Scheveiren's in the lower part of Aiken,) and a clay loam (Dr. Berckmans' in Georgia.)

I present the above facts as they have come under my own observation. I used in all these examinations a pocket glass of high magnifying power, and saw nothing which I considered necessary to be put under the microscope. Had the insect been present in any form, either as egg or living animal, I could not have failed to detect it.

Examinations made by Mr. Berckmans in 1875.

June 5th, 1875.—At Redcliffe, South Carolina, the residence of Harry Hammond, Esq., examined Pauline, Black July, Warren, White Chasselas, several varieties of Muscat and Malvaisia, soil a very stiff red clay, very compact; vines planted in 1859-60; cultivated three or four years, then abandoned; no culture for eight years, during which time vines were much injured by wagons running over them; ground plowed and vines received a working in the winter of 1874-75, the first in ten years. Growth luxuriant and most healthy, some of the foreign vines having canes of the new growth from four to seven feet; fruit scattering, but healthy; no trace of Phylloxera. N. B. The foreign vines are on their own roots.

August 12th.—Received to-day from Mr. Hammond, thoroughly ripe and perfect bunches of Chasselas from above vines. Wood and foliage perfect, notwithstanding most unusually hot and dry month of July.

June 7th, 1875.—Examined at Sandhills, Augusta, Concord, Ives, Gœthe, Wilder, Lindley, Maxatawney, Eumelan, Cynthiana, Brant, Cornucopia, Canada, Senasqua, Croton, Catawba, Warren; vines from two to seven years old; soil almost pure sand, kept well cultivated and fertilized with annual top dressings of bone-dust and leaf-mould; growth moderate in most varieties, owing to vines being closely planted and defective pruning; not a trace of insects. This vineyard is now yielding a heavy crop of perfect fruit.

July 30th—Examined a vineyard of a little more than one acre; vines trellised and kept in cultivation annually; vines four, six and eight years old. Catawba, Concord, Delaware, Diana, Wilder, Lindley; soil a compact whitish clay subsoil, commonly termed here crawfish land; top soil sandy; situation very low, and soil retentive of humidity, but well drained; vines very luxuriant; fruit abundant, sound and not a trace of Phylloxera.

August 10th—Dug up to-day a vine of White Chasselas, planted in 1858; vine was injured several times and repeatedly broken; first growth of the year was broken off when it had attained six feet; grew off vigorously, and set fruit on second growth; canes of latter six feet, very vigorous and healthy, and after submitting the rootlets to close investigation, failed to find a trace of insect; soil a rich, gravelly loam, two feet deep, and subsoil stiff, red clay.

From these notes it is evident that the presence of the Phylloxera is still unknown here; the vines examined at Sandhills had been received from various sources, north and west. Mr. Hammond's foreign vines were brought by him from the garden of the Luxembourg, Paris, in 1859. My foreign vines, of which I cultivated, in 1860–61, nearly 400 varieties, came from various sources; some from Paris, Angers, Nice, Hungary, Crimea, and a large portion from Algeria. Not a trace of Phylloxera has ever been discovered on any of them.

These reports are most interesting, and while they confirm the absence of Phylloxera in the vineyards examined, they also most eloquently support the views so repeatedly urged in my writings. Where the Phylloxera occurs, I have shown that the European vine languishes and by the third or fourth year perishes, while many of our own varieties also suffer and some of them succumb. Here we have instances, where no Phylloxera exists, of the European vines flourishing and bearing healthy fruit, as also many native varieties and hybrids, which in vineyards infested with Phylloxera, suffer or entirely succumb. One other fact comes out clearly from Mr. Berckmans' report: it is that the insect was not brought from any of the various parts of Europe from which he imported his foreign varieties. Facts like these are what we want, and not prejudiced opinions.

While it is made clear, therefore, that the Phylloxera does not occur around Augusta, the following letter from the Secretary of the Atlanta Pomological Society will show that it occurs about 160 miles westward of Augusta, in the same State; and I have little doubt but that the investigations of Mr. John T. Humphreys, who has recently been appointed State Entomologist of Georgia, will show us that it occurs more or less throughout the State:

C. V. Riley—*Dear Sir:* Your letter of Sept. 18th, and parts of 6th and 7th Annual Reports, were received, and my excuse for so long a delay in replying is absence from home and pressing business engagements. Early in October I took four vines from our vineyard that had the appearance of being unhealthy. Allen's Hybrid, Maxatawney, Walter and Delaware; all but the Walter had been planted three years—that two years.

Upon examination, with an inferior single lens glass (I could not get a good one in our city), I discovered insects, answering to the Phylloxera, on the roots of Maxa-

tawney and Walter, in considerable numbers, but failed to find any on the others, though the roots had every appearance of being affected. It was my intention to have made further investigations, but absorbing engagements prevented.

Atlanta Nurseries, Atlanta, Ga., Dec. 8, 1875. M. COLE.

In a subsequent letter Mr. Cole writes:

I regret that it is not in my power to furnish you with roots of the Maxatawney grape vine upon which I discovered Phylloxera, detailed in my letter of 8th December. The examination was made early in October, and the subjects destroyed by burning. The examination was carefully made, and the insects clearly defined in considerable numbers, and their movements observed.

AMERICAN GRAPE VINES IN EUROPE.

The demand has steadily increased in France for American vines, and especially those varieties which most resist the Phylloxera. Messrs. Jules Leenhardt, and M. Douysset, of Montpellier, who have been large importers, state that the orders during 1875 exceeded fourteen million cuttings, and though the orders have been largest for varieties of *æstivalis*, as Cunningham, Herbemont, Jacquez, many others, including wild vines, as the *æstivalis* of our woods, and the Mustang of Texas,* have also been sent over. There has also been quite a demand from Germany for our cuttings, as well as for seed of our different varieties.

The reason for this large demand is obvious. In spite of the liberal national reward offered in France for a remedy; in spite of the well directed and persistent efforts of the Government, and of the National Academy of Science; in spite of the fact that improved methods of employing the sulpho-carbonates have been discovered, and that the use of these compounds is declared by the Phylloxera Commission of said Academy to be satisfactory—the only remedy which has been applied on a large scale is submersion, which is not everywhere practicable, and the disease has steadily continued to spread.

During my visit to South France last July, I found that in many parts of the Department of Hérault, where four years before the whole country was one vast vineyard relieved only here and there by an olive orchard, the ground was devoted either entirely or partly to other crops, and the vineyards were fast disappearing. Yet right in the midst of this desolating work of the insect, the American vines were generally flourishing, and those who had carefully grafted their own varieties on to the roots of ours were elated at the prospect.

I made numerous notes and observations in different vineyards around Montpellier; but Messrs. Planchon and Viala have since, on

* Mr. Onderdonk in a letter to Mr. Isidor Bush, expresses the belief that the *vinifera* will not graft upon the Mustang. He has tried it repeatedly, and the grafts have always died the second or third year, after making a luxuriant growth.

behalf of a special committee appointed to report on the condition of American vines there, gone over the ground so thoroughly, in their report submitted last December, that I refer the reader more particularly interested to that paper,* as also to one by my friend Isidor Bush on "American Grape Vines in Europe," read at the last meeting of our State Horticultural Society. This last was published in the *Rural World* of February 23, and March 1, last, and is a valuable and temperate presentation of the case.

There has naturally arisen a good deal of feeling and discussion as to the merits of different varieties, and this was especially noticeable between the champions of the Concord on the one hand and those of the Clinton on the other; the latter making as much capital as possible out of a statement of mine, made at a special meeting of the Central Agricultural Society of Hérault, to the effect that while the Concord is hardy and prolific and resists the Phylloxera so well that it is the popular grape with us, I have nevertheless found vines dying in exceptional instances and evidently from Phylloxera.

The demand for some varieties has very much exceeded the supply, as the Summer of 1875 was unfavorable to the growth and ripening of grape wood; and I very much fear that the French recipients will experience some disappointment in 1876 in the growth of some of their cuttings, and in the nature of others, especially those sent from the South supposed to be the Jacques.

As a large portion of the grape wood sent over to France has been sent from Missouri, our grape-growers are interested in knowing what the prospects may be for future demands. It is evident that while the demand will not cease entirely, it will never be as great as during 1875, for even on the supposition that the varieties of *æstivalis* will be grown extensively throughout the Phylloxera district for their own grapes, and that the Clinton, Concord and Taylor will be as extensively used as stocks, the French nurserymen will be able from this time forward to measurably, if not entirely, supply the demand. California grape-growers will find it advisable to adopt the same course as have the French; and a good deal of grape-wood from the East may yet find its way there.

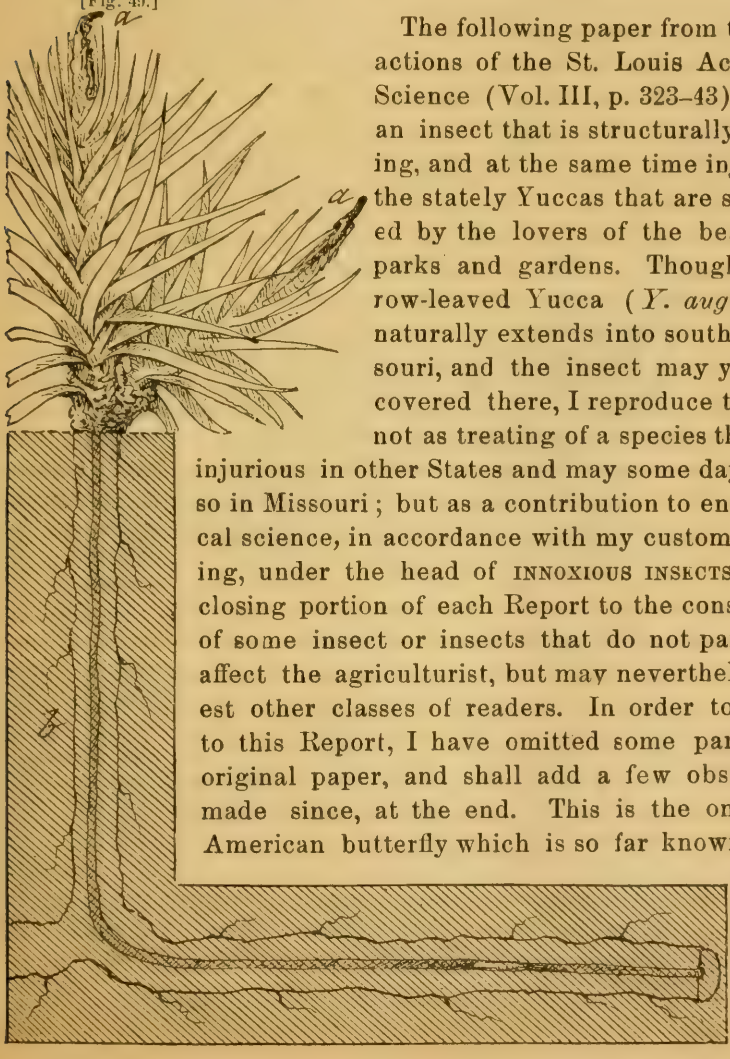
*Etat des Vignes Americaines dans le Départment de l'Hérault, pendant 1875. *Messager Agricole*, 10 Decembre, 1875.

INNOXIOUS INSECTS.

THE YUCCA BORER.—*Megathymus yuccæ* (Walker).

[Ord. LEPIDOPTERA; Fam. HESPERIDÆ.]

[Fig. 49.]



The following paper from the Transactions of the St. Louis Academy of Science (Vol. III, p. 323–43) treats of an insect that is structurally interesting, and at the same time injurious to the stately Yuccas that are so esteemed by the lovers of the beautiful in parks and gardens. Though the narrow-leaved Yucca (*Y. augustifolia*) naturally extends into southwest Missouri, and the insect may yet be discovered there, I reproduce the paper, not as treating of a species that is now injurious in other States and may some day become so in Missouri; but as a contribution to entomological science, in accordance with my custom of devoting, under the head of INNOXIOUS INSECTS, a small, closing portion of each Report to the consideration of some insect or insects that do not particularly affect the agriculturist, but may nevertheless interest other classes of readers. In order to adapt it to this Report, I have omitted some parts of the original paper, and shall add a few observations, made since, at the end. This is the only North American butterfly which is so far known to have the real boring habit in the larva state.

"He who, by a minute analysis of any animal, enables us to solve any dubious point connected therewith, does more for the elucidation of this much abused natural system than the greatest and most ingenious theorist who has yet taken the subject in hand."—WESTWOOD.

The study of aberrant forms in Nature is always interesting. They are continually confronting the naturalist. They baffle the systematist and constantly remind him of the necessarily arbitrary nature of his classificatory divisions. Few divisions seem more natural at first glance, than that of the Lepidoptera into Rhopalocera (butterflies or day-flyers) and Heterocera (moths or night-flyers). It was no sooner proposed by Boisduval than it was recognized as a most convenient arrangement, and adopted very generally. The antennæ in this Order are always conspicuous, and their clubbed or non-clubbed tips are easy of observation, and associated with other important characteristics which separate the two groups. The Sphingidæ, however, by their crepuscular habit and their antennæ thickening toward the end, though terminating abruptly in a point, bring the two groups in close relationship and diminish their value; while the Castniidæ on the one hand and the Hesperidæ on the other so intimately connect them, that it becomes almost a matter of opinion as to whether the former should be considered butterflies, or the latter moths. *Urania* and other abnormal genera* make the relationship of the two groups still more perplexing. On antennal structure alone —whether we consider the clubbed or non-clubbed tips according to Boisduval, or the rigidity, direction, and length, which Mr. Grote deems of greater importance†—two primary divisions cannot be based. If we take the spring or spine on the hind-wings, which is so characteristic of the Heterocera, we meet with the same difficulty; for a large number of moths do not possess it, while an accepted Hesperian (*Euschemon Rafflesiæ*, Macl.) from New South Wales is furnished with it. Nor is there any one set of characters which will serve as an infallible guide to distinguish moths from butterflies; and the number of moths described as butterflies, and the fact that Kirby considers the position of *Barbicornis*, *Threnodes*, *Pseudopontia*, *Rhipheus*, *Ægiale*, and *Euschemon*, included in his "Synonymic Catalogue of Diurnal Lepidoptera" as doubtful butterflies, gives sufficient proof of the truth of the statement. Between all classificatory divisions, from variety to kingdom, the separating lines we draw get more and more broken in proportion as our knowledge of forms, past and present, increases. Every step in advance toward a true conception of the relations of animals brings the different groups closer together, until at last we perceive an almost continuous chain. Even the older naturalists had an appreciation of this fact. Linnæus's noted dictum, "*Natura saltus non facit*," implies it; and Kirby and Spence justly observe that "it appears to be the opinion of most modern physiologists that the series of affinities in nature is a concatenation or continuous series; and that though an hiatus is here and there observable, this has been caused either by the annihilation of some original group or species * * * or that the objects required to fill it up are still in existence but have not yet been discovered." Modern naturalists find in this more or less gradual blending their strongest argument in favor of community of descent, and speculation as to the origin, or outcome rather, in the near present or remote past, of existing forms, is naturally and very generally indulged, even by those who a few years back were more inclined to ridicule than accept Darwinian doctrine. Shall we then say that the old divisions must be discarded because not absolute? As well might we argue for the abolition of the four seasons because they differ with the latitude, or because they gradually blend into each other! Entomologists will always speak of moths and butterflies, howsoever arbitrary the groups may come to be looked upon, or however numerous the intermediate gradations.

* Westwood (*Intr.* ii, 359) figures *Barbicornis Basalis*, God. as an Erycinid butterfly with tapering and ciliate antennæ.

† Proc. Amer. Assoc. Adv. Sci. xxii, B. 111.

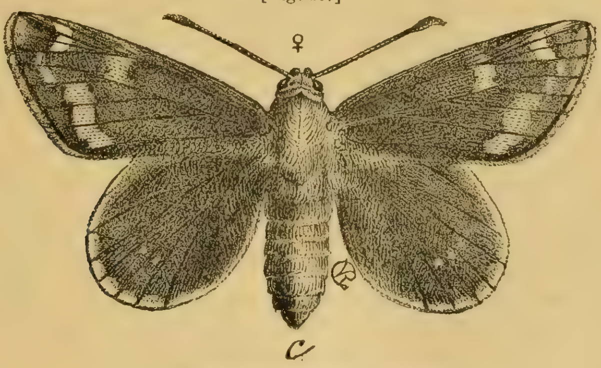
These thoughts naturally present themselves in considering so osculant a species as the Yucca Borer.

BIOLOGICAL.

The reader of these Reports is aware that the queenly Yuccas cradle and nourish a very curious and anomalous Lepidopteron—the *Pronuba yuccasella* (*cf.* Rep. V, pp. 150-60; Rep. VI, pp. 131-5). The genus is further interesting, from the entomological side, as giving us the insect under consideration.

In the home of the Yuccas, and more particularly in the home of the caulescent species, like *Y. aloifolia* and *Y. gloriosa*,* persons who have occasion to dig up the roots, or subterranean trunks, often notice that these are bored and hollowed out along the axis (Fig. 49, *b*), the burrow cylindrical, and lined at its upper end with silk, which is generally intermixed with a white glistening, soapy powder. These tunnelings are made by our Yucca Borer, which dwells therein; and their presence may generally be detected by masses of excrement observable among the leaves, and by certain chimney-like projections made by the twisting and webbing together of the more tender heart-leaves, or even of the flower-stalk, after they have been partly devoured, into a sort of funnel, from which the excrement is expelled (Fig. 49, *a*, *a*). The tunnelings weaken the trunk and induce rot, so that the plant is not unfrequently prostrated thereby; and as the insect is sufficiently common in the Gulf States to sometimes be found in every third plant over extended regions, its work renders the Yucca worthless as a hedge plant, for which it has been tried.

[Fig. 50.]



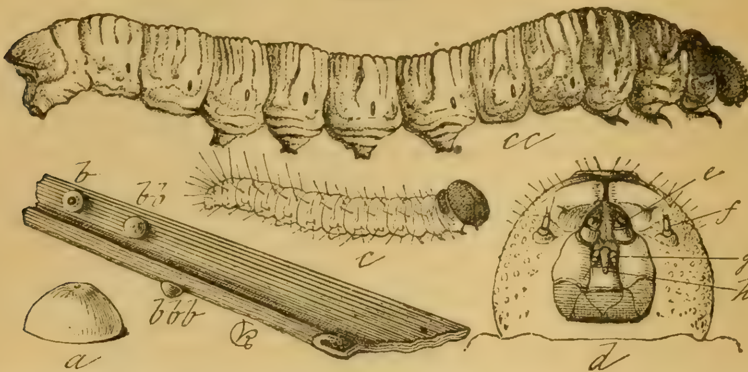
MEGATHYMUS YUCCÆ:—Female.

In the months of April and May, in South Carolina, but earlier in more southern latitudes, the parent Megathymus may be observed, where the Yuccas abound, passing, with very rapid, darting flight, from plant to plant, remaining but a few seconds at one place, during which she fastens an egg (Fig. 51, *bb*) to some portion of a leaf. She is generally seen at this work in the morning hours. The eggs, which are well-developed when she issues from the pupa, are laid singly, though several are often attached to the same leaf, generally near its tip and on the upper or under side indifferently. In the course of about ten days the young, reddish-brown larva (Fig. 51, *c*) gnaws its way out through the crown of the egg, and conceals itself in a web between some of the more tender terminal leaves. Generally, it will be found at first near the tip of a leaf

*Though I have positive proof of its working in *aloifolia*, *gloriosa* and *filamentosa*, its range does not seem to be co-extensive with this last species, as I believe the insect has not yet been reported north of latitude 36 degrees.

where the sides naturally roll up and afford a safe retreat. It then gradually works to the base, feeding the while and rolling and shriveling the blade as it descends. Other blades are often joined, and, in fact, the insect lives among the blades till it is about

[Fig. 51.]



MEGATHYMUS YUCCÆ:—*a*, egg, side view, enlarged; *b*, egg from which the larva has hatched; *bb*, *bbb*, unhatched eggs, natural size; *c*, newly-hatched larva, enlarged; *cc*, full-grown larva, natural size; *d*, underside of head of same, enlarged to show the trophi.

one-fourth grown, and seldom enters the trunk before that time. How soon, in the larval development the white powdery secretion already spoken of appears, or how many larval molts occur, has not been ascertained; but the more mature larva is always more or less covered with this powdery matter, which doubtless serves as a protection from the mucilaginous liquid which the tissues of the Yuccas contain and freely exude upon interference or maceration. Pupation does not take place till the subsequent late Winter or Spring; there being, from all that I can ascertain, but one brood each year. The burrow often extends two or more feet below ground, and during the coldest weather the larva probably remains in a partially dormant state at the bottom. Occasionally two larvæ inhabit the same trunk, in which case their tunnelings are kept separate, side by side. The pupa state (Fig. 52) is generally assumed just below the chimney-like funnel at the top of the burrow, and no other preparation is made for it than partial closing, near head and tail, to insure suspension. This funnel is, in reality, built and extended by the larva, and what little matter besides silk goes to make its exterior has been added and worked in from the outside. In the several larvæ that I have had feeding in breeding cages, this habit of building up and making tubes, for which remnants of leaves and other extraneous substances are pressed into use, struck me as quite characteristic; and in one instance I have had such a tube extended over nine inches from the tunneled trunk, the moss on which the section of Yucca rested being used in its construction.

[Fig. 52.]

MEGATHYMUS YUCCÆ:—Pupa.

In the issuing of the imago the pupa skin is rent on the middle of the notum and across the eyes, and the casings of the legs are never, and those of the antennæ seldom, severed from their solderings in the exuvium.

The imago rests (Fig. 53) with its antennæ, slightly diverging and generally directed forwards; with the wings elevated, closely ap-

pressed, and with the costa of primaries at an angle of about 45° from the body. Regarding the flight, which is diurnal, Dr. J. H. Mellichamp, of Bluffton, S. C., was impressed with the extremely rapid and darting motions of the insect as it passes from plant to plant; and Mr. E. A. Schwarz, of Detroit, who has had very excellent opportunity of observing the species in Volusia county, Florida, informs me that, when startled, Megathymus flies directly upward 20 or 30 feet, then horizontally for a long stretch—sometimes out of sight—and descends as directly as it rose. It frequents open places, is very shy, and generally settles near the ground.

[Fig. 53.]

MEGATHYMUS YUCCÆ:—Walking.

BIBLIOGRAPHICAL.

The first notice of this insect that we have any record of is that by Boisduval and LeConte, who figure it under the name of *Eudamus? yuccæ* on Plate 70 of their *Iconographie*.* Though there is no text accompanying the plate, it is evident, from the generic reference, that the insect is considered Hesperian, and no one could hesitate to so consider it if guided by the figures. In those of the imago the head is unnaturally broad, the body too slender, and the antennæ with the club too slender and too much hooked. The wings, in repose, are thrown forward as in *Thecla*; the antennæ erect, and the legs too slender. The larva has the large and nutant head, narrow thoracic joints, and green, yellow and white longitudinal stripes so characteristic of Hesperid larvæ. The pupa has much the form and color of *Epargyreus Tityrus* (Fabr.) In short, these figures, in many respects, and those of the larva and pupa more particularly, are so unlike the insect considered in the present paper, that the question might justly be raised as to whether I am dealing with the *Yuccæ* of Boisduval and LeConte, if the figures in the work in question were known to be generally trustworthy. But I have already shown† how inaccurate and unreliable some of the said figures are; while the food-plant, as indicated by the specific name, and the size, markings and color of the perfect insects in the plate, leave no doubt as to the identity of *Yuccæ* B. & L., and the species here considered. Too much imagination entered into the composition of that plate, and the probability is that after LeConte's figures were received in Europe by Boisduval, the latter, by mistake, coupled with *Yuccæ* the larva and pupa of some other large Southern Hesperian.

The next reference to this insect is by Walker,‡ in 1856, who is the first to briefly describe it as *Castnia yuccæ*. In 1871, Kirby referred it doubtingly to *Ægiale*, Feld. in Hesperidæ.§ In 1872, Scudder made it the type of a new genus (*Megathymus*) in Hesperidæ‖, without further diagnosis than the incorrect figures in the *Inconographie* alluded to. This reference is followed by Wm. H. Edwards in the Synopsis accompanying the first volume of his work on N. A. Butterflies (1872). Scudder subse-

* *Hist. Gén. et Icon. des Lépid. de l'Am. Sept*, 1833.

† Sixth Rep., p. 136.

‡ List of the specimens of Lep. Ins. in the Coll. of the British Museum, Part VII., p. 1583, No. 43.

§ Synonymic Cat. Diurnal Lep., p. 608. W. F. Kirby: London, 1871.

‖ Systematic revision of some of the Am. Butterflies, etc., p. 62. S. H. Scudder: Salem, 1872.

quently states that "it is not a butterfly,"* and Mr. A. R. Grote, after an examination of specimens collected in Florida, regards it "as belonging to the Castnians, where it is placed by Walker."†

It will thus be seen that this insect has sorely perplexed systematists, having been bandied from the butterflies to the moths; and that the balance of opinion withdraws it from the butterflies and places it with the Castnians—a family which. in some respects, combines the characters of the two great Lepidopterous divisions, but is regarded, and justly, as having most affinities with the moths.

I shall endeavor to show that this opinion is not well-founded; that *Megathymus* is a genuine butterfly, and that its greatest affinities are with the Hesperians. Together with one or two other species it forms a small, abberrant tribe; but, in order to more fully discuss its affinities, it is necessary to give an exposition of its characters, as no detailed descriptions have yet been published.

DESCRIPTIVE.

EGG—Subconical, the top flattened or depressed, and with a slight central dimple; the attached base concave; smooth but not polished. Color, pale green when laid, inclining to buff-yellow or brown before hatching. Diameter at base 2.5 mm.; height 1.8 mm.; the traverse diameter often varying slightly in two cross directions. Fourteen examined that were naturally deposited and many more in the ♀ abdomen.

LARVA—Newly-hatched larva (Fig. 51, *c*); Length 6 mm. Color dark brick-red with pitchy-black head and cervical shield; the abdominal joints showing two principal transverse folds. Six longitudinal rows (2 dorsal on anterior fold. 2 subdorsal, and 2 stigmatal on posterior fold) of black stiff hairs, arising either directly from the skin or from very small tubercles, longest posteriorly where they often exceed in length the diameter of the joint bearing them; some less conspicuous stigmatal and subventral hairs. Head larger than first thoracic joint, rounded, but rather flat in front; cervical shield narrow and in one piece; both minutely punctate. No anal plate. Full-grown Larva (Fig. 51, *cc*—Average length 2.60 inches; diameter 0.40 inch. Color edematous white. Surface faintly aciculate, and sparsely armed, dorsally, with minute, evenly distributed, short, rufus bristles, springing from the general surface, and not very noticeable with the naked eye; covered more or less copiously with a white, glistening, powdery secretion.‡ Cylindrical, the abdominal joints with 8 annulets, the first 3 occupying anterior half, the 3rd most prominent and widening laterally, and the other 5 on the hind half of the joint—all best defined dorsally. The thoracic joints somewhat larger than the rest, more deeply and irregularly wrinkled; the substigmatal region with longitudinal folds. *Head* black, perpendicular, and asperous or deeply shagreened; epistoma and labrum brown, small, and usually with a transverse median ridge. the ⅄-shaped mark white, forking before the suture, and the forks having the shape of U: mandibles stout, subtriangular, non-dentate: antennæ (Fig 51, *f*) 2 jointed, exclusive of bulbus, the terminal joint twice as long as the basal, sometimes showing a faint constriction, and with an apical nipple and long seta: maxillæ and labium and mentum forming a subquadrate piece, bulging out prominently from beneath, the parts seemingly soldered together and separated only by deep sutures, the maxillary palpi (Fig. 51, *e*) consisting of two broad joints, the second surmounted by two stout nipples squarely docked at tip, the inner one stoutest and both armed with bristles (the parts not clearly shown in figure): the labium small, trapezoidal, highly polished, with the spinneret (*h*) twice as long as palpi (*g*) which are small, recurved and 2-jointed, exclusive of bulbus: a few stout bristles on labrum, on palpigerous piece of maxilla, on mentum, base of mandibles and around the ocelli, which are not easily distinguished from the more globular of the shagreenations. Cervical shield more glabrous than head, and scarcely darker than the body except around hind border. *Thoracic legs* very short but stout, with the horny parts deep brown, and sparsely armed with bristles. Prolegs well developed, the hooks in double row and forming a distinct purple-brown, transversely oval annulus, but slightly broken at the narrow ends. *Anal shield* rounded behind, coreaceous rather than corneous, and with a slight increase of bristly hairs, especially around border. *Stigmata* large, with a purple-brown, oval annulus.

* Historical Sketch of Generic Names proposed for Butterflies, p. 213. Salem, 1875.

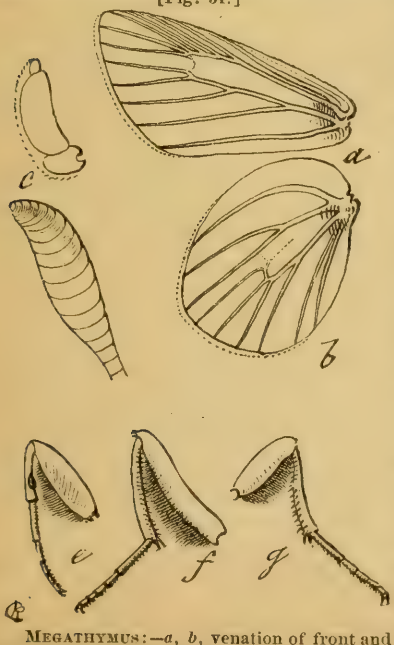
† *Canadian Entomologist*, September, 1875, p. 173.

‡ This secretion is of a waxy nature, analogous if not identical with that secreted by so many Homopterous and some Hymenopterous larvæ. It is soapy to the touch, and dissolves readily in alcohol, leaving however a distinct scum on the surface.

PUPA—Average length 1.50 inches. Cylindrical; broadest at shoulders, the abdomen large, recurving ventrally toward anus, and terminating in a broad, flattened, posteriorly rounded, transverse, slightly decurving flap, the borders thickened basally and extending ventrally so as to surround the bilobed anus. Eyes prominent, with a transverse carina: wing-sheaths reaching hind part of 4th abdominal joint, ventrally; hind tarsi to about the hind third of these, and the club of antennæ—which forms a prominent bulge but tapers to a point—nearly as far. Surface but slightly polished and faintly corrugate; a few extremely minute bristle-like spines distributed over the abdominal joints, dorsally, and the two or three terminal joints with stiff rufous hairs, increasing posteriorly and thickest on the flap. Chitinous covering delicate, and all the members clearly defined. Prothoracic spiracle showing as an opaque, dull fulvous elliptic-ovoid wart. Color brown-black anteriorly, paler on the abdomen, and more or less densely covered with a white powdery secretion like that which characterizes the full-grown larva.

IMAGO.—Generic Characters—Head small, the width, including eyes, not much more than half that of the mesothorax; the antennal bulbus large, and the inter-antennal space not wider than one of the sockets; covered with rather evenly shorn, dense hairs, and flattened scales not overhanging the eyes. Eyes small and smooth. No ocelli Labial palpi (Fig. 54, *c*) stout and short, not reaching to top of eyes, 3-jointed, the basal joint broad but short, the middle joint 4 times as long, the terminal joint tuberculous and one-sixth as long as the preceding: clothed in short and thick hair-like scales. Tongue filiform, rather more than one-half the antennal length. Antennæ rigid, cylindrical, terminating in an elongate knob (Fig. 54, *d*) which is slightly flattened and slightly tapering and recurved at tip, but without apical spine or tuft: having rather more (♂) or rather less (♀) than half the costal length of primaries. *Thorax* very robust, recalling that of *Xyleutes;* clothed with close-lying hair which becomes longer and looser behind; the patagia rather broad, forming two crescent-shaped, slightly raised layers; the tegulæ closely appressed. Legs (Fig. 54, *e*, *f*, *g*, front, middle and hind) with brushy hairs beneath the femora; the tarsi all studded beneath with minute reddish spines, the hind and middle tibiæ still more strongly spined, and each with a pair of more prominent spine-like, apical spurs of equal size, and hardly longer than the other spines in ♂ and not longer than the diameter of tibiæ in ♀: the front tibiæ unarmed, the nodule on the inner apical third ovoid and dark: tarsal claws with a very small pulvillus between them: front femora 5.5 mm. long; tibiæ rather more than half as long; tarsi as long as femora: middle femora 7.4 mm. long; tibiæ and tarsi but slightly shorter: hind femora same length as front ones; tibiæ one-fifth longer.

[Fig. 54.]



MEGATHYMUS:—*a*, *b*, venation of front and hind wings; *c*, labial palpus, denuded; *d*, club of antenna; *e*,*f*,*g*, front, middle and hind legs.

Wings, with the scales small but mostly long, narrow and dense, with long hair at base superiorly and with the general shape and venation (Fig. 54, *a*, *b*) of *Hesperia*, the primaries with the apical angle more acute, but less so than in *Thymele;* anal angle not produced but rounded: secondaries narrow and more rounded than in any other Hesperid genus known to me: veins quite stout. *Abdomen* ♀, very stout and heavy, thickening behind, blunt at tip, and truncate below; ♂ more slender and gradually tapering. Specific Characters.—Average expanse 2.50 inches; length of body 1.12 inches. General color, above, deep umber-brown, the body more grayish, especially the tegulæ; the longer hairs of the mesothorax and base of abdomen inclining to ferruginous: whitish in front and around the neck and back of the eyes. Primaries with a notched ferruginous band on the outer fourth bounded by veins 1 and 4; a narrower mark running from the posterior margin of this between 4 and 6; a paler mark in a line with the first band between 6 and 9, and a ferruginous mark again just within the discal area—the veins traversing the spots showing distinctly black: an apical shade, a costal streak between veins 8 and 9, and alternate marks on the fringes, are pale yellowish; while the basal hairs are ferruginous. Secondaries with a ferruginous border and straw-yellow fringes. In the ♂ the antennal stem is paler, the spots on primaries smaller and paler, and the border on secondaries wider; while in the ♀ the secondaries have from two to four ferruginous spots

just outside of the disc and between the inferior veins.* Beneath, the whole coloration is brighter, the spots between veins 6 and 9 being pure white, the others saffron-yellow, and the posterior portions of all the wings, and a broad costal streak on secondaries, pearly-gray; a spot of the same color is observable on the outer third of secondaries below vein 2, a more distinct and triangular mark on the inner third just below the costal vein; while the orange superior spots in ♀ show dark brown. The antennæ are white with the exception of the club; the palpi and front trochanters whitish-gray, deepening posteriorly. The legs are brown with the tarsi but faintly tinged with gray.

The ten specimens that have come under my observation show considerable variation, aside from that which is sexual, in the depth of color and size of the spots, as well as in the distance between them and the hind border of the wing; but none of them have the spot on primaries, indicated in one of Boisduval's figures, just within the middle of the wing and below vein 2.

AFFINITIES.

Let us now compare the foregoing detailed characters with the Castnians on the one hand and the Hesperians on the other.

Scudder, who has certainly given more attention than perhaps any other author to the Hesperians, divides them into two groups, which he considers of tribal value.† The first to which he applies Latreille's name *Hesperides* is characterized chiefly by the primaries in the ♂ having a costal fold (often inconspicuous, however;) by the posterior extremity of the alimentary canal being protected beneath by a corneous sheath, which extends beyond the centrum or body of the upper pair of abdominal appendages, sometimes nearly to the extremity of the appendages; by the club of antennæ being elongate, roundly bent, or with a sinuous lateral curve; by the prevailing color being dark brown with white or translucent angular spots; by the stout body and swift flight; by the eggs being distinctly ribbed vertically; and by the larvæ generally feeding on leguminous plants and living in horizontal nests made with the leaves. The second tribe, to which he gives Hübner's name *Astyci*,‡ the front wings of ♂ have no costal fold; the extremity of the alimentary canal is not protected by any extruded sheath; "the prevailing tints of the wings are tawny and black, marked also but often feebly with pale, sometimes vitreous, spots;" the antennæ have a stout club, which either tapers rapidly or is devoid of a crook; the hind wings are usually horizontal in rest; the eggs are smooth, usually broader than high; and the larvæ "feed on Gramineæ, and generally construct vertical nests among the blades."

The eggs of the Castnians are, so far as I am aware, unknown and undescribed. In both butterflies and moths they present an infinite variety in form, in sculpture, and in the manner in which they are laid. As a rule, however, those of the larger moths are either ovoid, spherical or flattened, and rarely subconical or sculptured; while those of butterflies are more often conical, and present greater variety in form and sculpture. The eggs of Hesperians are subconical, and those of the Astyci, as we have just seen, in being smooth and broader than high, agree exactly with those of *Yuccæ*.

The larvæ of the Castnians are, according to Boisduval§, endophytous, boring the stems and roots of Orchids and other plants, like the Sesians and Hepialians, and like *Yuccæ*. But they are ornamented with the ordinary horny piliferous spots or warts which characterize Heterocerous larvæ, and have a horny anal plate. Butterfly larvæ, on the contrary, rarely possess these warts, but frequently have the body uniformly beset

* The secondary sexual characters are confounded by Boisduval, as quoted by Morris (Synopsis of Lep. of N. A., p. 113,) though, as there is no text in the *Iconographie;* the error doubtless originated with Morris in making descriptions from the figures.

† Bulletin Buffalo Soc. Nat. Sci., p. 195.

‡ I think such diversity of ending in terms used for divisions of the same value should be avoided.

§ Suites à Buffon; *Sphingides, Sesiides, Castniides;* Paris, 1874.

superiorly with close-shorn bristles as in *Yuccæ*, such bristles generally springing from minute papillæ. The newly hatched larvæ of the two divisions approach each other more nearly in general appearance, as all animals do, the farther we go back to the commencement of individual life; but though the newly hatched larva of *Yuccæ* bears a general resemblance to the same stage in many endophytous Heterocerous larvæ (e.g. *Xyleutes*, *Cossus*,) yet in the stiff hairs springing from the general surface, or from very minute points, instead of from distinct tubercles, it agrees with the Rhopalocera. The legs, both false and true, together with their armature and the trophi, are so extremely variable in both divisions that comparisons can hardly be instituted. The endophytous habit, though very exceptional, is found in butterflies (e.g. *Thecla Isocrates*, Fabr.: see Westwood's Intr., ii., p. 369.) None of the Heterocerous borers, so far as my experience goes, line their burrows continuously with a matting of silk; but use the silk very sparingly, or not at all, till about ready to pupate. The larva of *Yuccæ*, for the most part, lives in a tube of silk, which it builds and extends often several inches beyond the trunk or stem in which it burrows. and from which it often, especially when young, issues to feed. In this, again, it approaches the Hesperians, which are partial concealers, and live, when not feeding, within silken cases or tubes constructed among the leaves of their food-plants.

The pupæ of the Castnians, like those of all Heterocerous borers known to me, are, according to authors, armed with rings of minute spines on the hind borders of the abdominal joints—the spines serving a very useful purpose in assisting the pupa out of its cocoon. Heterocerous borers also pupate in a more or less perfect cocoon, made either within or without the burrow; and, in the issuing of the imago, the mesothoracic covering generally collapses, the leg-cases become unsoldered, and those of the antennæ are always separated and often curled back over the head in the exuvium. The Hesperians pupate within the silken cavity occupied as larva, or else in a separate slight cocoon: the pupa is generally attached to a silken tuft by the hooks of the cremaster, and sometimes by a silken girth around the middle of the body besides; it is not unfrequently covered with a slight powdery bloom, and is characterized by the prominence of the prothoracic spiracle*: the exuvium more nearly retains its form, the leg-cases remaining soldered, and even those of the antennæ being rarely separated. In not having a well-formed cocoon, in being covered with bloom, in the characters of the exuvium, in the conspicuity of the prothoracic spiracle, but more particularly in the want of minute spines on the borders of the abdominal joints. *Yuccæ* is again Hesperian and not Castnian. Indeed, except in the broader anal flap, densely surrounded with stiff bristles, in place of an apical bunch of hooks, in the smaller head and larger body, it resembles *Nisoniades* in general form, color, and texture.

The typical Castnians, in the perfect state, have the wings large with loose and *very large* scales, and the hind-wings *invariably* armed, at costal base, with the *long stout spine*, or spring, which serves to lock the wings in flight by hooking in a sort of socket beneath the primaries, and which is so characteristic of the Heterocera. The venation resembles more nearly that of the Hepialians, and is totally unlike that of the Hesperians. The veins are slender; in the primaries 1*a* and 5 are as stout as the rest; the discal cell is short, connected transversely with 3 and with an areolet above: in the secondaries the cell is nearly obsolete, and the independent or vein 5 of secondaries is as stout as the others. (Comp. Fig. 54 *a. b.* with Fig. 55) The antennæ, though thick-

* In *Nisoniades Juvenalis* (Fabr.) this spiracle takes the form of a prominent sooty-black horn or tubercle.

[Fig. 55.]

Venation of Castnia Pharis (Fabr.)

ened at tip, are generally long and more or less supple, and there are two distinct ocelli between the eyes, behind the antennæ. The Castnians vary much in general appearance, but whether we deal with the Brazilian *Castnia Linus* (Cram.) with its narrow, elongate, rounded, clear-spotted wings, and its remarkably elongate and swollen basal joint of the middle tarsi; or with *C. Licus* (Cram.) which has broad, angular wings; or with the genera *Ceretes*, *Orthia*, *Gazera*, and *Synemon*—we find the characters above mentioned constant: they are typical of the Family and are Heterocerous characters. *Yuccæ*, on the contrary, has none of these characters, but in the smaller wings, in their venation, in the closeness of the small and narrow scales and hairiness at base, in having no ocelli, and in the unarmed secondaries, entirely agrees with the Hesperians. I attach much less importance to the antennæ, size of head and body or even the spurs of tibiæ; because they are all more variable. Thus, while most of the Castnians have the antennal club tipped with a spine or a bunch of bristles, others (e. g. *Castnia Orestes*, Walker, from Surinam,) have it of the same shape as in *Yuccæ*, and unarmed or even more short and blunt (*Synemon Theresa*, Doubl.) Again, in most Hesperians the club tapers, or is curved at tip; but there are all degrees of variation, from the extremely curved club of *Epargyreus Tityrus* (Fabr.) to the straight and blunt club of *Oarisma Poweshiek* (Parker). The small head and subobsolete spurs in *Yuccæ* are abnormal compared with either family; for most of the Castnians have the spurs much as in *Hesperia*, and the head almost as broad as the thorax. In the stiffer, relatively shorter antennæ, with large club; in the spines which stud the tibiæ,* as well as in the stoutness of the thorax and abdomen, *Yuccæ* is again Hesperian rather than Castnian. The Castnians, like the Uranians, and many other exceptional moths, resemble the butterflies in being day-flyers; but the position of the wings in repose, which is a more important character, is said by all observers to be similar to that of *Catocala*, *Drasteria*, and other Heterocera, viz.: deflexed or incumbent. *Yuccæ*, both in manner of repose, in color, and in pattern, is a staunch Hesperian.

In short, a careful consideration of the characters of our Yucca Borer shows that in all the more important characters it is essentially Hesperian; and that in most of those characters by which it differs from the more typical species of that family—as in the small spurs, in having only the apical ones on the hind tibiæ, in the tibial spines, and difference in size of legs—it is more Rhopalocerous than Heterocerous. The same holds true when we consider the adolescent states. In the small head of both larva and imago, and in the very large abdomen, it is abnormal; but these characters are traceable to the abnormal larval habit, and are very unimportant compared to the pterogostic and other characters cited. I have long since concluded that general larval form and appearance is so dependent on habit and so variable according to habit, that it is less valuable than more minute structural characters, and that for purposes of classification it has even less value than egg structure, and infinitely less than imaginal characters. All endophytous Lepidopterous larvæ, of whatever family, have certain general resemblances that are a consequence of similarity of habit; and I give it as my emphatic opinion that *Yuccæ* is a large bodied Hesperian, which, though approaching the

*In the Castnians that I have been able to examine none of the tibiæ have spines, while those on the tarsi are very minute; the middle tibiæ have a pair of unequal, prominent sub-apical spurs, and the hind tibiæ have two similarly unequal pairs, the anterior pair from about the terminal fifth.

Castnians through *Synemon*, has no real relation with them. In certain marked characters it departs from the Hesperians as at present understood, and the only question which a careful study of the species gives rise to in my mind is—not whether it should be considered a Castnian, but whether it offers characters that necessarily separate it from the Hesperians. Families should, I think, be made as comprehensive as possible and not unduly multiplied; and in considering aberrant forms, the objects of classification are best subserved by retaining them in whatever division can claim the balance of characters. It is better to widen than to restrict in the higher groups. LeConte does better service in bringing Platypsylla among the Coleoptera than does Westwood in creating a new Order—Achreioptera—for it. Phylloxera, in Homoptera, is much more wisely retained in the Aphididæ than made the type of a new Family. Let *Yuccæ*, therefore, be retained in Hesperidæ. By its aberrant characters it may constitute the type of a third tribe, for which I would propose the name *Castnioides*. This Tribe consists at present, in addition to *Megathymus yuccæ*, of two other good species,* the one from Mexico, the other from Costa Rica. It is very probable that the number will be greatly increased as we become more familiar with the Lepidopterous fauna of Mexico and Central America, where the Yuccas and Agaves abound; for I have little doubt that the last-named plants will also be found to nourish other species of the Tribe.

ENEMIES.

I have reared from the Yucca Borer eleven Tachina flies, all belonging to the species which I have designated *anonyma*, and which infests the larvæ of a number of other Lepidoptera.† The fact that *Yuccæ* is attacked by such a parasite is further proof that it is more or less an external feeder, since it is hardly probable that the parent Tachina would enter the burrow, and I know of no genuine endophytes that are similarly attacked.

CONCLUSION.

Whether we have in our Yucca Borer a remnant of more ancient and synthetic types from which the Castnians on the one hand and the Hesperians on the other are derived, or whether we have in it a more recent variation from the more typical Hesperians, are questions which, with present knowledge, permit only of a speculative answer. The former hypothesis is, however, the more plausible. The Castnians, while occurring in Mexico, find their greatest development in Central America and Brazil. The few Castnioides known, inhabit the southern part of North America. During the tertiary period, when the ocean reached over the whole Mexican plateau northward, the fauna of North and South America was much more similar than at the present time. It is not difficult to conceive how a Lepidopterous family that was then common to both divisions of the continent, may since that time have deviated in the two directions indicated, and yet have left some less modified forms in the intermediate country. We are assisted in this conception if we view, with some botanists, the Yuccas as remnants of an ancient flora.

We may learn from the history of this butterfly, as from that of the Hackberry butterflies,‡ how unsafe it is to describe, and particularly to create genera, from mere drawings. Megathymus, as founded on Boisduval's figures, is very much of a myth. It

Ægiale Kollari Felder and *Æ. indecisa* Butler and Druce.

†4th Rep., p. 129.

‡6th Rep., p. 150.

is so with all genera erected by the mere coining of a name without recognizable definition; and while a Hübner, in making a number of divisions on superficial grounds, may accidentally hit upon relationships which subsequent research proves correct, he certainly does not greatly benefit science by his work. Again, we may learn the necessity for the adoption by entomologists of some rules for guidance in matters that do not come within the scope of present accepted rules. Can names connected solely with published figures be accepted? Shall we write *Yuccæ* Boisduval or *Yuccæ* Walker? Such questions become the more important when two different names are employed. A figure, however good, cannot be considered a definition; and, whilst most entomologists would consider that the species in question had not virtually been named until described by Walker, others take a different view, and perhaps with reason, since a good figure, so far as recognition of the thing intended is concerned, is infinitely more definite than the majority of the earlier descriptions of species in entomology.

In conclusion, I take pleasure in expressing my obligations to Mr. W. F. Kirby, of Dublin, Mr. John A. Ryder, of Philadelphia, and Mr. Herman Strecker, of Reading, Pa., for kind assistance in my studies of this insect; and more particularly to my esteemed correspondent Dr. J. H. Mellichamp, of Bluffton, S. C., for his efforts in furnishing material, and to my friend Mr. S. H. Scudder of Cambridge, Mass., for valuable aid, always freely given.

Since the above article was written I have been able to make some further observations on the manner of pupation, on the flight of the butterfly and on the early larval habit.

The exposed portion of the blackened, chimney-like funnel, made by the larva, has a length of from four to six inches; but the funnel virtually extends from one to three inches below the still green and growing leaves before it reaches the more solid portion of the trunk where the true burrow may be said to commence. Throughout this entire length the funnel is elastic with a tendency to contraction. It is within the hidden base of this elastic funnel, or just above the burrow proper, that the pupa state is generally, if not always, assumed. A more careful study of Yucca tops in which the pupa was naturally formed—i. e. in plants not cut till after pupation—shows me, also, that the partial closing of the burrow near head and tail is due solely to the elasticity of the funnel. No additional silk is used, and nothing that can well be called a cocoon is constructed. Just above the natural contraction that occurs at the junction of the more elastic with the more firm and solid portion of the burrow, the pupa rests—the cast-off larval skin generally helping to close up the lower passage. Here the pupa has perfect freedom of motion, and readily twirls the lower part of the body when disturbed. The natural recurvature of the abdomen, as shown in the figure, presses the bristled, dorsal and terminal portion of the body on the one side, and the ventral, middle portion on the other, against its elastic confines, and holds it securely. A few muscular movements, aided by the leverage and hold which the aforementioned bristles insure, bring the

pupa, when the imago is about to issue, toward the top of the funnel, which readily opens under the pressure, since it is closed only by contraction. In the issuing of the imago the pupa remains within the tube.

Having let several of the butterflies loose in a spacious chamber in order to watch their movements, I can confirm what has been said of the rapidity and strength of their flight. I would further add, that, in resting or walking, as in all their actions, they have the characteristics of the larger bodied skippers. When the wings are not used in flight, the inferior portion of the secondaries is folded along vein 1 and tucked in under the submedian, as is, I believe, the case with all Hesperians. At rest, the outer portions of primaries are brought closely together. The favorite position of the insect when at rest is vertical, or even hanging from beneath an oblique object. In walking, the wings open more or less, but the hind ones are not held horizontal. In walking on a flat surface, the fore body is strongly raised on the legs, while the end of the abdomen, especially in the female, generally touches the ground, so that the costæ of primaries are nearly on a plane with the surface. The antennæ are most often on a plane with the body, and strongly diverging.

About the middle of April I had a number of larvæ hatch, and have been able to watch these on two plants of *Y. aloifolia* in-doors and on one out-doors. The habit of living at first within a cylinder made by one of the rolled leaves, webbed across with silk, is very marked, and even where the larva at first works at the base of a leaf it will web the leaf up and feed along up to its tip before entering into the more solid portions of the plant. In extruding the excrement the larva backs up to the end of the retreat which is kept only partially closed. One specimen I have kept from the time of hatching in a tin box, occasionally supplying it with fresh leaves. It forms a retreat of these and appears to thrive as well as the others. It went through the first molt the 10th day after hatching, and through the second molt 11 days subsequently, and, judging from the size of the head in this third stage and of the insect, there will be two more molts or four in all. Toward the end of the third stage the larva measures 1.20 inches.

In the *second stage* the head is deep gamboge-yellow, with dark jaws—not polished but faintly chagreened: the cervical shield is narrow, entire and polished black; and an anal plate is obvious, also polished, dark brown, with the hind borders thickened and black. The body is olivaceous-brown, the stiff, black hairs of the first stage are very much shortened and pale, and the whole surface has a faintly pubescent appearance, caused by numerous minute points, each giving rise to a short soft hair. The wrinkles of the mature larva are already well defined. In the *third stage* the head is chesnut-

brown, and the stiff, piliferous hairs are scarcely longer than the other minute ones on the general surface. The larva has now all the characteristics of the last stage, except in lacking the white powder, and in being of a pale olive-brown color. The cervical and anal shields are still highly polished and black, and the skin, instead of looking faintly pubescent, as in the previous stage, is translucent and glossy.

Where several larvæ hatch out on the same plant (which not unfrequently happens,) there is a struggle as to which shall usurp the privilege of entering the stem, and the first one to do so generally keeps the others out on the leaves, so that in the end they doubtless perish. The parent is by no means particular as to where she fastens her eggs, for Dr. Mellichamp has sent me dry leaves of *Quercus falcata* that had accumulated around his Yuccas, and that have eggs fastened to them.

Regarding the boring habit in butterflies I learn from Prof. P. C. Zeller, of Stettin, Prussia, that there is also a Hesperian (*Erynnis alceæ*, Esp.; *malvarum*, Hoffm.) which Kirby gives as common to Europe, Asia and Africa, whose larva bores in Autumn into the stems of its food-plant, (*Malva sylvastris*) in which it hibernates, and in which it goes through its transformations the following Spring.

THE ARMY WORM.

ADDITIONAL NOTES ON THE MODE, PLACE AND TIME OF OVIPOSITION.

COMPLETION OF THE INSECT'S NATURAL HISTORY.

It gives me pleasure to announce ere closing this Report that, since the article on the Army Worm was written and printed, I have been able to settle by direct observation the questions therein discussed as to the time, place and manner of oviposition. By persistently searching during the early part of April for the moth, I was rewarded by taking a number of specimens at sugar and others at large and while engaged in the act of laying. All the latter specimens have been found in an undisturbed blue grass plot behind the St. Louis fair grounds. As they are not easily disturbed while in the act of oviposition, it is only occasionally that one will fly up from the disturbance of walking over the grass. They fly low and soon bury themselves in the grass. By carefully watching I have ascertained that the favorite place to which the female consigns her eggs in such grass is along the inner base of the terminal blades where they are

yet doubled. The compressed, horny ovipositor, which plays with great ease and tentative motion on the two telescopic subjoints of the abdomen, as described on p. 32, is thrust in between the folded sides of the blade, and the eggs are glued along the groove in rows of from five to twenty, and covered with a white, glistening adhesive fluid, which not only fastens them to each other, but draws the two sides of the grass blade close around them, so that nothing but a narrow glistening streak is visible. I think also, that the two edges of the grass blade are sometimes clasped by the opening hind border of the ovipositor, so as to give the insect a firmer hold, and fold the leaf more closely on the eggs. Finding it difficult to make satisfactory observations in the field, I transferred living moths to glass cages which were furnished with blue grass sward. Here again most of the eggs were laid in the manner described, and on the green and dry blades indifferently: some were, however, thrust in between the sheath and stalk, as I had anticipated they might be, while others were thrust into the crevices on the sides of the sward, which had been cut with a knife.

The female having once commenced to lay, is extremely active and busy, especially during warm nights, and I should judge that but two or three days are required to empty the ovaries, which have a uniform development. A string of 15 or 20 eggs is placed in position in two or three minutes, and by the end of ten more I have known the moth to choose another leaf and supply it with another string. Many must be laid very soon after vegetation starts, as some moths taken in the middle of April had already exhausted their supply; yet the bulk of them are not laid till toward the end of April. Very few of the moths and only those captured at sugar looked at all fresh, while all those having the eggs fully formed showed unmistakable signs of having hibernated; in fact most of those found laying had the wings so tattered and rubbed that they were scarcely recognizable. The moth perishes within a day after having exhausted her supply of eggs. The egg is glistening white when first laid, and only becomes tarnished or faintly dull yellowish toward maturity. Just before the hatching of the larva which, in a uniform temperature of 75° F. takes place from the 8th to the 10th day after deposition, the brown head of the embryon shows distinctly through the shell. The newly hatched larva is dull translucent white in color, with a uniformly brown head, and the two front pair of prolegs are so atrophied as to necessitate the looping of the body in traveling. The development of my larvæ, reared in a uniform room temperature of about 80°, has been remarkably rapid. They underwent five molts and but three days intervened on an average between each. Yet under the same

conditions, the issue from the same string of eggs will manifest considerable variation, and some of them have passed through the last before others have reached the fifth.

It is thus evident that the conclusions arrived at in the body of this Report on such points as had not been settled by direct observation, are essentially correct so far as the above recorded facts bear on them. The only part needing correction is on pp. 35–36, where the statement that the moth will not oviposit in confinement, should be qualified by adding, "when reared indoors from the larva," which was indeed implied. When the ovaries are fully developed the moth will oviposit under any circumstances, and will thrust her eggs into any recess whatever, or even scatter them on the ground. I doubt very much whether she can well deposit her eggs in the favorite position, except where the grass is quite thick, or where there is a matting of old grass, as she could not well support herself where the blades are single and sparse; and from this view we get another reason why burning all the old and prostrate blades and stalks prevents the origin of the worms, in such burned places. I will conclude these supplementary notes with descriptions of the egg as laid, and of the different larval stages.

Egg—When first laid, spherical, 0.02 in diameter, smooth, opaque white; covered with a glistening adhesive fluid; shell delicate, becoming faintly irridescent and more sordid before hatching.

Immature Larva—When newly hatched 1.7 mm. long: dull translucent white in color, with very minute piliferous points giving rise to pale hairs. Head large and uniformly brown-black. Two front pair of prolegs atrophied so as to necessitate looping in motion. Drops by means of a web. In the *second stage* it is quite active, still loops, and spins a web and drops at least disturbance. Head copal yellow, with six black ocelli (the two inferior somewhat separated from the others) the brown jaws, and brown marks on the legs conspicuous. Color of body yellowish-green; darker anteriorly, the venter being quite pale. The lines of mature larva barely indicated in faint, rose-brown; the most conspicuous being the broad stigmatal, a narrower one above it, and two which are medio-dorsal. In the better marked specimens, the body above the pale substigmatal line consists of 8 dark and 7 pale lines, the middle pale line medio-dorsal, the second dark one from it most faint and most often obsolete, and the lower or stigmatal one broadest and most conspicuous. Black piliferous dots distinct and normally arranged, i. e., on the middle joints 4 trapezoidally on dorsum; 2 in stigmatal dark line, one just above, the other just behind stigmata; one at lower edge of pale substigmatal line near the middle of the joint, and several that are ventral: the dorsal ones on joints, 1 and 12 forming a reversed trapezoid to those on middle joints; on jt. 11 a square, and on jts. 2 and 3 a transverse line. In the *third stage* there is little change. The head has still a copal yellow aspect, being pale with faint yellowish, brown mottlings, the ocelli still conspicuous. The body is more decidedly striped, the dark stigmatal and pale substigmatal lines more strongly relieved and all the lines approach more to those of last stage. The pale hairs from piliferous dots are still quite noticeable especially before and behind, and the dots themselves are generally relieved by a pale

basal annulus. The looping habit is lost, but the front prolegs are still somewhat the smallest. It now curls round and does not spin in dropping. In the *fourth stage* the aspect is quite changed, the general color being dull, dark green. The head has the mottlings of a deeper brown and the characteristic brown lines appear. The second pale line (from above) is obsolete, and the other five are narrowed, pure white, and sharply relieved by dark shades. The prolegs are of nearly equal size; the cervical shield better defined: in short, except in the lighter substigmatal stripe and more greenish color, the characters of the more normal, mature larva obtain. In the *fifth* and *sixth stages* the changes are mainly in the increasing prevalence of the brown and ferruginous colors, and the greater relief and intensity of the black, especially above the upper white lateral line. The front prolegs in the last stage are, if anything, longer than the hind ones. I reproduce herewith, with a few additions, my original description of the

Mature larva.—General color dingy black, appearing finely mottled and speckled under a lens, with the peliferous spots placed in the normal position, but scarcely visible, though the soft hairs arising from them are easily seen with a lens. Four lateral light lines, of almost equal thickness, and at about equal distance from each other, the two uppermost white, the two lowermost yellow; a much less distinct medio-dorsal white line, frequently obsolete in middle of joints, and always most distinct at the divisions: a jet black line immediately above the upper lateral white one, the dorsum near it, thickly mottled with dull yellow, but becoming darker as it approaches the fine dorsal white line, along each side of which it is perfectly black. Space between lateral light lines 1 and 2, from above, dull yellow, or reddish, the white lines being relieved by a darker edge; that between lines 2 and 3 almost black, being but slightly mottled along the middle; that between 3 and 4 yellow, mottled with pink brown, and appearing lighter than that between 1 and 2. Venter greenish-glaucous, mottled and speckled with neutral color, especially near the edge of the 4th lateral line. Legs glassy and of same color as venter, those on thoracic joints with black claws, those on abdomen with a large shiny black spot on the outside. Stigmata oval, black, and placed in the 3d lateral light line. Head highly polished, pale grayish-yellow, speckled with confluent fuscous dots; marked longitudinally by two dark lines that commence at the corners of the mouth, approach each other towards the centre, and again recede behind; on each side are four minute polished black eyelets, placed on a light crescent-shaped ridge, and from each side of this light ridge a dark mark extends more or less among the confluent spots above. Cervical shield polished and mottled like the head, with the white medio-dorsal and upper lateral lines running conspicuously through it. Anal plate obsolete.

These descriptions apply to the average specimens, and, as stated on page 45, there is considerable variation in all stages.

INDEX.

ERRATA.

Page 34, line 6, for "*Noctulièles*" read "*Noctuélites.*"
Page 34, line 6, for "three-hundredths" read "two-hundredths."
Page 38, line 6, for "glass" read "grass."
Page 121, line 18, add "and" before "except."

NINTH ANNUAL REPORT

ON THE

NOXIOUS, BENEFICIAL,

AND OTHER

INSECTS

OF THE

STATE OF MISSOURI,

MADE TO THE STATE BOARD OF AGRICULTURE, PURSUANT TO AN APPROPRIATION FOR THIS PURPOSE FROM THE LEGISLATURE OF THE STATE.

BY CHARLES V. RILEY,
State Entomologist.

JEFFERSON CITY:
REGAN AND CARTER, STATE PRINTERS AND BINDERS.
1877.

PREFACE.

To the President and Members of the Missouri State Board of Agricultnre:

GENTLEMEN:—The following pages constitute my Ninth Annual Report on the Noxious, Beneficial and other Insects of the State of Missouri, laid before you in synopsis at your last annual meeting.

During no year since I have been studying the habits of the insects of our State, have the farmers enjoyed such general immunity from insect ravages as during the past year, if we except the work of the Rocky Mountain Locust toward the end of the growing season. This immunity was largely due to the wet character of the summers of 1875 and 1876; for it is a fact that I have frequently laid stress on, that the larger number of the cultivator's worst insect enemies thrive and multiply most during dry seasons. While there was general immunity from insect ravages throughout the State, it was all the greater and more noticeable in the western counties which, in 1875, had been so sorely afflicted. The native locusts were scarce, the Chinch Bug was scarcely heard of, and the general freedom from noxious species, there, which I had anticipated in my Eighth Report, was the subject of remark with all close observers.

It is unnecessary to call particular attention to the subject matter of this Ninth Report, further than to state that a preponderance of space is devoted to that Western scourge, the Rocky Mountain Locust, which again invaded, from the Northwest, most of the fertile country between the Mississippi and the Rocky Mountains, and laid eggs over a larger area than ever before. Reaching our western counties late in the season, the insects did comparatively little damage in Missouri, except to Fall wheat, which was mostly eaten down and killed. They left their eggs, however, and much injury may be anticipated this Spring. A repetition of the ravages of 1875 is probable, but not in the counties most ravaged that year, which will not materially suffer.

The particular counties in which injury may be anticipated are detailed on p. 67. In order that the Report may be distributed among the farmers in those counties in time to be of service to them, I have hastened its publication by omitting articles on the Hessian Fly, the Grape Phylloxera, and some other insects which I had more particularly studied the past year.

In proportion as this Report, and the preceding one for 1875, are circulated in the western counties; in that proportion will the labor bestowed upon them and the experience contained in them prove profitable to the State. I sincerely hope, therefore, that the illiberal spirit manifest in the Twenty-ninth General Assembly, in the attempt to abolish the State Board of Agriculture, and the refusal to make any appropriation therefor, will give place to more generous and enlightened action that will increase rather than diminish the means for usefulness of the only State organization created especially for promoting the farming interests of the State.

In this, as in the previous volumes, when the insects treated of are new, or the existing descriptions of them are imperfect, or in a foreign language, or in works out of print or difficult of access, I have added a full description, which is, however, always printed in smaller type, so that it can be skipped by the non-interested reader. I have endeavored to give a popular name to each insect of economic importance, and this is invariably accompanied, wherever accuracy demands it, by the scientific name, and the latter is generally printed in *italics* and mostly in parenthesis, so that it may be skipped by the practical man without interfering with the text. The Order and Family to which each insect belongs, are generally given under each heading. The dimensions are expressed in inches and the fractional parts of an inch. Where so small, however, as to render such measurement inaccurate, I have adopted the milimeter—one milimeter (1 mm.) not quite equaling twenty-five hundredths of an inch (0.25 inch.) The sign ♂, wherever used, is an abbreviation of the word "male," the sign ♀ for "female," and the sign ☿ for neuter.

Some of the figures are enlarged, but the natural size of each of such is also given or indicated by a hair-line, except in the representation of enlarged structural details, where they are connected with the life-sized insect to which they belong.

The name of the author of the species, and not of the genus, is given as authority; and in order to indicate whether or not the insect was originally described under the generic name which it bears, I have adopted the following plan: When the specific name is coupled with the generic name under which it was first published, the describer's name is attached without a comma—thus indicating the authorship of the dual name: e. g. *Phycita nebulo* Walsh. But when a different generic name is employed than that under which the insect was first described, the authorship is enclosed in parenthesis thus—*Acrobasis nebulo* (Walsh;) except where the whole name is already in parenthesis, when a comma will be used for the same purpose: e. g. (*Acrobasis nebulo*, Walsh.)

All the illustrations, unless otherwise stated, are drawn by myself from nature

Respectfully submitted,

CHARLES V. RILEY,

State Entomologist.

ST. LOUIS, MO., March 14, 1877.

TABLE OF CONTENTS.

INNOXIOUS INSECTS.

NOXIOUS INSECTS.

CURRANT AND GOOSEBERRY WORMS.

The Currant and the Gooseberry, though not among the choicest of our fruits, yet possess, with their peculiarly sub-acid or their spicy flavor, qualities which make them invaluable for the manufacture of jellies and conserves, and render them most grateful and healthful in the hot summer months. Their cultivation is somewhat neglected in Missouri, and though more general farther north and east it has there fallen off within the past twelve or fifteen years, principally on account of the increase of those insects which injuriously affect the plants. Those, therefore, who desire to successfully grow the Currant and Gooseberry must familiarize themselves with, and learn how to effectually deal with the insect enemies which attack them. Chief among these are several so-called "worms" which prey upon the leaves, and by repeatedly defoliating the bushes, not only prevent the fruit from maturing, but eventually cause the death of the plant. In some sections the injury has been so serious that the culture of these fruits has been abandoned.

It is the common but misleading practice for writers in our horticultural journals to refer to any of these insect enemies of the Currant and Gooseberry as THE Currant Worm or THE Gooseberry Worm, as though there was but a single species injurious to these plants; whereas, in reality, there are quite a number of species that affect them in stem, leaf and fruit. As a rule each requires a different mode of treatment, according to its habit; but I shall here consider only the three principal leaf-feeders, which may all be destroyed by one and the same means.

These three species formed the subject of an editorial article published some years ago in the *American Entomologist* (Vol. II, No. 1)

which is now so scarce that it cannot be had in the market. The portion on the Gooseberry Span-worm was written by myself; that on the Currant worms by my associate, B. D. Walsh, the facts in possession of either being interchanged, as was our custom. While I am able to record some interesting observations made since that time, the article was to that extent exhaustive of the subject, that I shall quote liberally from it, rather than recast the facts in different language.

Notwithstanding that the Currant and Gooseberry differ so much in general appearance—the former being a smooth-stemmed shrub, bearing its flowers and fruit in a raceme, while the latter has, as a rule, thorny and prickly stems, and bears its berries singly—they are placed by botanists in the same genus (*Ribes*). Our common Garden Gooseberry (*Ribes grossularia*) was imported from Europe, but we have four wild species commonly found in the Northern States; and besides these four there is a Californian species, the Showy Gooseberry (*R. speciosum*) which is sometimes cultivated as an ornamental plant in our gardens, for the sake of its fine, deep-red, pendant flowers. On the contrary, our common Red Currant (*R. rubrum*), of which the White is a mere variety, is indigenous in the more Northern States, from New Hampshire to Wisconsin, though also a native of Europe; while on the other hand, the Black Currant of our gardens (*R. nigrum*) is a European plant, considered by botanists to be distinct from the American wild Black Currant (*R. floridum*). Besides these, we have three other currants peculiar to America, the Prostrate or Fetid Currant (*R. prostratum*) found in cold Northern woods, the Missouri or Golden Currant, (*R. aureum*) and the Red-flowered Currant (*R. sanguineum*) both of which are natives of the Far West, and are cultivated chiefly for ornament.

These botanical details will not be uninteresting by way of preface to what follows; for the three worms to be described, while they are found indiscriminately on the Red Currant and Gooseberry, are not found on the Black Currant.*

Our Wild Black Currant has a Lepidopterous borer peculiar to it; while the common Currant-borer of our gardens (*Æ. tipuliformis*) which belongs to the very same genus; and the Common Currant Plant-louse (*Aphis ribis*) both confine their attacks to the Red Currant, and do not affect the Black Currant or the Gooseberry. These facts are not only very interesting as showing the slight discrimination

* Mr. Saunders records (*Can. Ent.* II. 147) having found the Imported Currant-worm in the act of feeding not only on the Black Currant, but also on the Plum; but the fact that all larvæ which he endeavored to rear on such leaves eventually died, shows how exceptional and abnormal is their feeding on those plants, and that they cannot, in the true sense of the word, be considered Black Currant or Plum feeders.

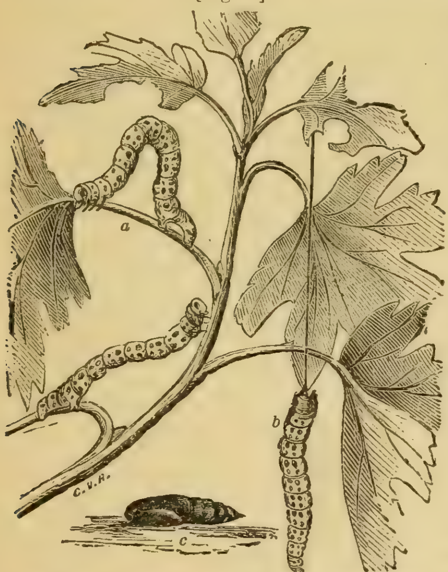
which insects sometimes make between plants of the same genus; but they are of much practical importance, as a knowledge of the peculiar tastes and preferences which insects frequently manifest for different species, or even different varieties of plants, will be of much value in guiding us what to plant.

THE GOOSEBERRY SPAN-WORM—*Eufitchia* ribearia* (Fitch.)

[Ord. LEPIDOPTERA; Fam. GEOMETRIDÆ.]

ITS NATURAL HISTORY.

[Fig. 1.]



GOOSEBERRY SPAN-WORM :—*a*, *b*, larvæ; *c*, pupa.

In the month of May, in the latitude of St. Louis, gooseberry bushes, and more seldom currant bushes, are sometimes suddenly stripped of their leaves by a yellow, black-spotted worm which generally remains unnoticed during the early part of the month, when small and hidden by the foliage. It is the most common and destructive of the gooseberry leaf-eaters in Missouri, and, being a looper or span-worm, is at once distinguished, by its mode of progression, from the other worms to be mentioned. When full grown it measures about an inch, and is of a bright yellow color, with lateral white lines and numerous black spots and round dots, as shown in the accompanying figures. The head is white, with two large black eye-like spots on the outer sides above, and two smaller ones beneath. The six true legs are black and the four prol egs yellow. It drops readily by a web and attains its growth from the end of May to the middle of June, when it descends to the ground and either burrows a little below the surface or hides under any rubbish that may be lying there; but in neither case does it form any cocoon. Shortly after this it changes to a chrys-

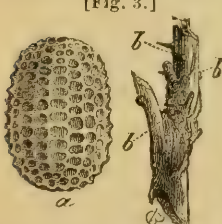
*This insect was originally described by Fitch under the generic name *Abraxas*, with a question as to the correctness of the generic reference. It has also been very generally referred to *Ellopia*, but Dr. Packard in his recent admirable *Monograph of the Geometrid Moths*, very properly defines the genus under the name *Eufitchia*, the insect in question being the only species belonging to it.

alis (Fig. 1, *c*), of the usual shape, and shining mahogany-brown in color. After remaining in this state about fourteen days, it bursts the chrysalis shell, and in June and the forepart of July appears as a moth (Fig. 2). This last is of a pale nankeen-yellow, the wings rather gauzy and shaded with faintly dusky or leaden-colored spots. These are arranged in no very distinct pattern, but form a more or less conspicuous band across the outer third of all the wings, and give a soiled appearance to the basal portions. The spots are always largest and most intense in the middle portion of each wing. The under surface repeats the upper, and the legs, body and feelers are somewhat brighter, or orange. In the male the feelers are feathered or ciliated; in the female they are simple. These moths may invariably be noticed hanging listlessly about the bushes two or three weeks after the worms have disappeared, and even where the latter have not been numerous enough to attract attention, the moths they have produced may generally be noticed in the month of June, moving with languid flight about the bushes, or darting somewhat more actively from place to place when disturbed. Like the rest of their family, they are nocturnal and, except when aroused, or in cloudy weather, usually remain quiet during the day. The females, soon after issuing from the ground, begin to lay their eggs, fastening them simply to the twigs and more permanent parts of the plant, and principally on the main stems near the ground and beneath the branches. The preference for the inner, more basal and protected portions of the plant, over the terminal or more exposed parts, I have found quite decided. From being laid singly and from possessing protective coloring, these eggs are with difficulty noticed, and have never hitherto been described. I had on several occasions, in years gone by, obtained what were evidently, from comparison with those found in the ovaries, the eggs of this species, but not until last spring did I succeed in hatching therefrom the larvæ, under conditions where they could be watched, or in getting the females to lay in confinement. The egg is irregularly ovoid, slightly compressed, 0.7 mm. long, $\frac{2}{3}$ as wide, pale bluish-green in color, with irregular, sub-hexagonal reticulations, so as to give a rather deeply pitted appearance something like the surface of a thimble, there being 15 or more longitudinal rows of these pits. It reminds one in fact of the pitted grain of the berry of *Atropa belladonna*. It is attached as often on one side as on end.

[Fig. 2.]

Female Moth of Gooseberry Span-worm.

[Fig. 3.]



EGG OF GOOSEBERRY SPAN-WORM:—*a*, enlarged; *b*, natural size.

This insect is single-brooded, and the eggs are exposed to all the heat of summer, and the vicissitudes of winter, without losing their vitality. At length, when the proper time arrives, and the Gooseberry and Currant unfold their leaves so as to afford plenty of food, these eggs hatch, and in little more than three weeks the worms attain their full larval development.

HOW IT SPREADS.

Owing to the above peculiarity and to the fact that the eggs are attached to the permanent parts of the plant where they are with difficulty seen, the species is frequently carried in the egg state upon transplanted bushes from one neighborhood to another; which accounts for its sudden appearance in parts where it was before unknown.

A NATIVE SPECIES.

This Gooseberry Span-worm is a native American insect, not to be found on the other side of the Atlantic. There is, however, an allied species (*Abraxas grossulariata*), which in Europe infests Currant and Gooseberry bushes in much the same manner as our species does here. The two insects were at one time supposed to be identical, but the European species is at once distinguished by its black, white and yellow markings in the larva and imago states; and by forming its chrysalis above ground. It used to be very common in a dearly-loved garden at Walton, England, where, in watching its metamorphoses I first, as a child, became interested in insect life—the bright colors and striking pattern of the species in all stages, and its external habit, making it a most convenient object for study.

ITS PAST HISTORY.

Our species undoubtedly fed originally on some one or all four of our indigenous gooseberries, but after the introduction of the European gooseberry it very soon manifested its preference for the latter, and, under the new conditions, multiplied so rapidly as soon to become a serious pest. The depredations of this insect in some of the Eastern States, particularly in New York and Pennsylvania, date back a great number of years. In the West it was first noticed by myself (*Prairie Farmer*, July 16, 1875) in the neighborhood of Chicago, in 1862, where for a few years afterward it multiplied to an injurious extent.

In Missouri, my attention was first called to it in May, 1868, by Mr. T. W. Guy, then living at Glenwood. His gooseberry bushes had been entirely denuded of their leaves by it. Mr. Huron Burt of Williamsburg, on May 30, 1870, sent me specimens of the worms, with the statement that they had been defoliating his gooseberry bushes, and

that where the foliage was insufficient they would finish up on the fruit. Quite frequently, since then, I have in my travels found the gooseberry bushes in the eastern counties of the State defoliated by this pest; but it is seldom complained of in the western counties, and Mr. Walsh, in the course of twelve years collecting, met with but a solitary specimen of the moth, near Rock Island, Illinois, although the wild gooseberry was abundant in the woods in that locality.

IT PREFERS THE GOOSEBERRY TO THE CURRANT.

This insect shows a decided preference for the Gooseberry, always attacking that plant first when growing side by side with currant bushes. Hence, and because it is generally preferable to apply the popular name of an injurious insect to the state in which it commits its depredations, I have given it the distinguishing term of "Gooseberry Span-worm," though Fitch originally called it the American Currant Moth. The term "Currant Geometer or Measuring Worm" has subsequently been used without any particular reason.

THE MOTH IS CLOSELY IMITATED.

There is another moth common in Missouri and in most parts of the country, which in flight and general appearance bears so close a resemblance to the parent of our Gooseberry Span-worm that the two at first sight are easily confounded, and furnish a remarkable illustration of the fact that insects differing widely in structural details often have stamped upon them the same general appearance, where what naturalists understand as "mimicry" could apparently have had nothing to do in bringing about the resemblance. I refer to a little moth often seen fluttering about the Fragrant Sumach (*Rhus aromatica*) on which its larva perhaps feeds. It has precisely the same color and very much the same markings and differs from the Gooseberry moth only in details of venation, in the simple feelers in both sexes and in the somewhat smaller size, more rounded and more diaphanous wings. It has been referred to an entirely different Family (*Bombycidæ*), but evidently belongs to the Geometers.

PARASITES.

No parasite has been mentioned by previous writers as attacking the Gooseberry Span-worm, but I have reared an undescribed Tachina-fly from its pupa.

REMEDIES.

Many different applications have been used to kill this worm. A correspondent of the *Country Gentleman* (June 17, 1869) mentions having used skim milk with good success. The Gooseberry Span-worm of Europe, already referred to, is fought with a decoction of

Elder leaves boiled until the liquid becomes black. Into this is then mixed an equal quantity of tobacco water. Fox-glove leaves are also used for the same purpose. Sulphide of potassium in dilute solution (one part in 500) is also used in France, and even air-slacked lime is found useful when the worms are young. The same remedies would doubtless apply to our species, but white hellebore, as I shall presently recommend it for the other worms, is most available and most effective, though less satisfactory than when applied to them. The habit which the worms have of letting themselves down by a web when disturbed, renders hand picking quite effectual if done when they are young. It will be most effectual where the bushes are well-trimmed. By shaking these with a forked stick, and then passing the stick under the suspended worms, the latter may be drawn onto the ground and crushed. It is a good plan also to dig around the bushes, after the worms have entered the ground to transform, so as to expose them or the chrysalides to birds. Where practicable, poultry may be used to good advantage in this destruction.

Three other Span-worms * are mentioned by Packard and Saunders as infesting currant bushes; but none of them are spotted and marked as that under consideration, and none of them have ever been known to multiply to the same injurious degree. They all occur in Missouri, and the moths are more often met with than the worms.

THE IMPORTED CURRANT WORM—*Nematus ventricosus* † Klug.

[Ord. HYMENOPTERA ; Fam. TENTHREDINIDÆ].

The two insects next to be treated of belong to a class of leaf-feeding worms not heretofore noticed in my Reports, namely, the false caterpillars or slugs. With the exception of the wood-boring Horntails (*Uroceridæ*), and a few of the Gall-flies (*Cynipidæ*), they are the only insects of their order that injure vegetation to any considerable extent. The false-caterpillars are so named on account of their general resemblance to the ordinary caterpillars

**Angerona crocataria* (Fabr.), *Amphydasis cognataria* Guen., and *Endropia armataria* (H—S.).

†As with so many other insects, this species has received many names, and through the carelessness of describers, and the tendency to erect species on the most trivial differences, it has become almost impossible to unravel its nomenclature. Mr. Walsh has, however, endeavored to do so (*Pract. Ent.* I. 125). The name which I employ, and which has been very generally accepted, was given to it in 1819 by Klug; but as, according to Seibold, Klug's name was what we call a mere museum name, and Scopoli had described the ♂ as early as 1763 (*Entomologia carniolica*, 280) by the name of *ribesii*, the sticklers who allow nothing but the strictest law of priority, carried back to its utmost limit in point of time, will have a chance to fly in the face of modern authors who have employed Klug's name, by adopting Scopoli's, albeit his *ribesii* was a description of but one sex and not of the species. In 1823 the ♂ was described as *affinis* and the ♀ as *trimaculatus* by St. Fargeau; and it is under this last name that Dr. Fitch published an extended article on the species (Trans. N. Y. St. Agr. Soc. 1867, pp. 909-932)—strangely overlooking the sexual distinctions after they had been clearly pointed out by Mr. Walsh. It has at different times been christened *ribis* by two different authors; also *ribesii grossulariæ* and *grossulariatus*.

of moths or butterflies. They are easily distinguished from the latter, however, by never having less than six, and often as many as eight, pairs of prolegs; whereas no true caterpillar has ever more than five pairs. The prolegs also differ structurally in lacking the rim of minute hooks which characterizes those of true caterpillars. The perfect insects are termed Saw-flies, from the peculiar saw-like structure of the ovipositor, which will be more particularly referred to further on.

The species under consideration is one of the most destructive members of the family, and though not so widespread as the Gooseberry Span-worm, it is far more troublesome than any other currant insect in most of the Eastern States. I have neither met with it, nor been able to trace its occurence, with any degree of certainty, in Missouri; but as there is good evidence that it occurs already in Illinois, and Mr. Jno. W. Byrket found it in 1870 around Indianapolis, Ind., I have thought best to forewarn and forearm those of our citizens who are interested in berry culture, by laying before them a full account of it.

ITS INTRODUCTION AND SPREAD.

It first began to attract attention in this country around Rochester, N. Y., about the year 1857—the first explicit reference to it being found in the *Rural New Yorker* for July 24, 1858. It was generally supposed to have been imported along with some gooseberry bushes from Europe, by the celebrated Rochester nurserymen, Messrs. Ellwanger and Barry: but Mr. Barry informed me, while at his beautiful place in 1871, that it was first known to occur around Toronto, in Canada, before it appeared around Rochester.

"In nine years time, besides colonizing in other directions, it had gradually spread to Washington county, N. Y., on the east side of the Hudson River—a total distance of about 225 miles. Thus, as it appears, it traveled at the average rate of some twenty-five miles a year, establishing a permanent colony wherever it went, and not passing through the country as a mere moveable column of invaders. In 1860 or '61 it appeared at Erie, in the N. W. corner of Pennsylvania. In 1864 Prof. Winchell found it at Ann Arbor, Michigan. In 1866 it was generally distributed over the N. E, counties of Pennsylvania. And, judging from a conversation which we had in October, 1868, with Mark Carley, of Champaign, in Central Illinois, this gentleman must have had it in great numbers upon his currant bushes in the summer of that year. At all events he described the worm which had infested his bushes as being green, with many black spots, and as not being a looper.

"But besides the principal centre of distribution at Rochester, N Y., this Currant-worm seems to have been imported from Europe at one or two other points in the Eastern States, and, as at Rochester, to have spread therefrom as from a focus. Unless our memory greatly deceives us, Mr. Geo. Brackett, of Maine, described this same insect many years ago, as existing in that State, though he gave it a different specific name, and was not at all aware that it had been introduced from the other side of the Atlantic. We also heard of it in the summer of 1867, from Mr. A. H. Mills, of Vermont, as being very destructive in his neighborhood. Not improbably, it was independently imported at other points in the East. Wherever it is introduced it spreads with great rapidity, and as there are two broods every year, it soon multiplies so as to strip all the currant and gooseberry bushes bare and utterly ruin the crop, besides eventually destroying the bushes, unless proper measures be taken to counteract it."

According to Dr. Fitch, who, in the article already alluded to, has given a very full account of its spread over the Western States, it kept the bushes so destitute of leaves in most of the gardens at Watertown, N. Y., that in three years they were nearly or quite dead.

It now occurs in all the New England States, and according to Mr. Wm. Saunders, throughout Canada from Halifax to Windsor.

ITS NATURAL HISTORY.

The perfect insects come out of the ground soon after the leaves of the current and gooseberry bushes put forth in spring. The female lays her eggs along the principal veins on the underside of the leaf, (Fig. 4, 1). These eggs, though but slightly attached, yet increase in bulk after deposition, as is the case of all Saw-fly eggs known to me, when inserted into the plant-tissue. Such swelling has been explained heretofore solely on the principle of endosmosis, and if such were the only explanation it would strongly argue that the eggs in this instance, must be slightly inserted in the leaf tissue. Indeed Siebold, in some elaborate observations on this insect, which I shall more particularly refer to further on, finding that the eggs shrivelled and died in measure as the leaves upon which they were deposited dried up, investigated the subject very carefully, and

[Fig. 4]

IMPORTED CURRANT WORM:—Leaf showing eggs (1), and holes which the young worms make (2, 3.)

declares that the female ruptures, with her weak saws, the epidermis of the leaf-ribs, and thus brings the surface of the egg in very close connection with the exposed parenchyma.*

He further remarks that the rupturing or scratching (Verletzung) which *Nematus ventricosus* causes in ovipositing is "probably confined to the epidermis and may therefore be easily overlooked." This may account for the fact that Mr. Saunders† states, after carefully looking into this matter, that he is fully satisfied that the eggs are not embedded in the leaf tissue at all, but fastened very slightly to the surface. Upon subsequently questioning Mr. Saunders more particularly about it, he wrote (May 25, 1874): "Whatever Siebold may say, I cannot help. My microscope does not show *me* the egg as pushed through the epidermis—it appears distinctly on the surface—it is very different from the Rasberry saw-fly in this respect." Dr. A. S. Packard, Jr., also states (*Embryological Studies* in Mem. Peabody Ac. of Sc., Vol. 1, No. 3,) that the eggs are simply glued to the surface, and this is the experience of all other American writers on the subject. The investigators named are all most careful observers and good microscopists; yet either there is error somewhere, or else, which is an interresting possibility, the insect has been modified in habit since its introduction to America.

While in the majority of cases in America, as observed by Saunders and Packard, the abortive saws of the female may not rupture the epidermis; in some cases, however, they certainly do; for in most but not all the specimens which I have examined, I have detected the slight rupturing mentioned by Siebold. It is still plainly discernible in a dried leaf now before me from Mr. J. A. Lintner, of Albany, N.Y., and yet containing well formed eggs that were parasitized. Nevertheless, when made, it is so slight as to be altogether insufficient to support the egg without the adhesive fluid that accompanies it. The eggs, while attached, appear no more inserted than are those of the genus *Lyda*, and differ materially in this respect from those of all other Saw-flies known to me.

Siebold himself remarks that there can be, with such slight skinning of the epidermis, but little vital intercourse between the egg and the plant, and the facts that I have recorded as to the swelling of the eggs of our Katydids when fastened to perfectly dry and dead substances (Rep. V, 124,) would indicate that the swelling is not due solely to endosmosis from the attached parts of the plant, but depends on another principle, difficult to analyze, but evidently more or less atmospheric.

*Beitr. zur Parthenogenesis der Arthropoden, 1871, p. 123.

†*Am. Entomologist* II, 274; *Can. Ent*, II, 112.

Mr. Saunders has found as many as 101 eggs on three contiguous leaves.

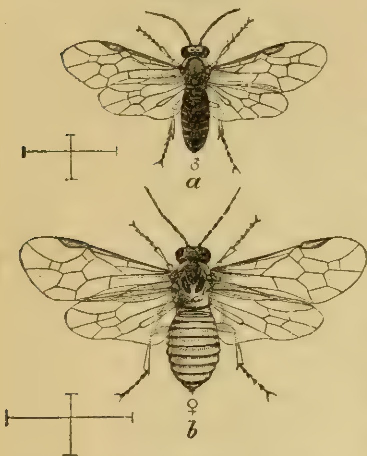
The eggs hatch within a week or ten days according to the weather, into pale 20-legged larvæ with a large dull whitish head, having each side the black spot so characteristic of Saw-fly larvæ belonging to the same genus. The color soon becomes green, and as the worms molt they acquire black, shiny spots on the body, and a black head. After the last molt the spots are shed again, and the color is entirely grass-green, except the dark head-spots, and a yellowish tinge on the first and the anal joints. In the annexed Figure 5, *a*, *a*, *a*, *a*, show larvæ of different sizes in different positions; and *b* gives an enlarged view of one of the abdominal joints in profile, so as to exhibit the position of the black spots. "When full-grown the larvæ are about three quarters of an inch long, and from their greatly increased size, make their presence readily known by the sudden disappearance of the leaves from the infested bushes. Shortly afterwards, having attained a length of fully three-quarters of an inch, they burrow under-ground, generally beneath the infested bushes, or, if there are many leaves lying on the ground, simply hide under those leaves. In either case they spin around themselves a thin oval cocoon of brown silk, within which they assume the pupa state." Frequently, however, as has been fully proved by Mr. Saunders, and as has been recorded by European observers, they form their cocoons in the open air, on the bushes, or under any extraneous shelter that is at hand. "About the last week in June or the first part of July, or occasionally not until the beginning of August, the winged insect bursts forth from the cocoon and emerges to the light of day; when the same process of coupling and laying eggs is repeated. The larvæ hatch out from this second laying of eggs as before, feed on the leaves as before, and spin their cocoons as before; but the perfect fly from this second brood does not come out of the coccoon till the following spring, when the same series of phenomena is repeated." At least such is the case ordinarily, though a third generation is sometimes produced.

[Fig. 5.]

IMPORTED CURRANT WORM:—*a*, *a*, *a*, larvæ; *b*, a magnified joint of body, showing black tubercles.

Mr. Saunders has given some reason to believe that a few of the second brood of larvæ may exceptionally hibernate as such.* This in itself is not impossible, but cannot, by any means, be looked upon as proved. The impression rests on the fact that on the 31st of May, 1869, he found a cocoon attached to a bag which he had tied on a gooseberry bush on the 22d of the same month. We all know that the Gooseberry is one of the first plants to blossom and leaf, and that in all ordinary seasons a worm such as our Currant-worm would have ample time to acquire full growth by the last of May at London, Ont. In point of fact Mr. Saunders himself found worms feeding the very next year in the very same locality, as early as the 10th of May.† Yet he could not suppose these had hibernated because he at the same time found eggs upon the leaves, some of which must have been laid two weeks earlier. The flies are known to issue in April even in Northwestern New York, where, though on about the same latitude, the opening of spring is later than at London, Ont. Moreover, in the very first article appearing upon the insect in this country (*Rural New Yorker*, June 24, 1858), the worms are described as appearing "in succession occasionally from March till October, but in greatest numbers in June." And, allowing the spring of 1869 to be unusually late, I cannot see why a cocoon found the last day of May should not have been made by a worm hatched from an egg deposited by an early developed fly; for it is more likely that an early female should deposit a few eggs on the yet unfolded buds than that the worm should, as such, weather the winter's severity except when shielded by its cocoon.

[Fig. 6.]



IMPORTED CURRANT WORM:—*a*, male; *b*, female fly, the hair lines showing nat. size.

"From the drawings of the male and female‡ fly given herewith (Fig. 6), the reader will see at once that the two sexes differ very widely. This is very generally the case among the Saw-flies, and it is a remarkable and most suggestive fact that, when this takes place, the body of the male is almost invariably darker than that of the female. Nor does our species, as will be observed at the first glance, form any exception to the rule." Indeed, as with several other species and

*Can. Ent., II, pp. 16, 48.

†*Ibid*, p. 112.

‡The abdomen in this cut should show only 9 joints.

notably the saw-flies (genus *Lophyrus*) which affect the White Pines and which will be treated of further on, the body of the male is almost entirely black and that of the female almost entirely yellow.

PREVENTIVE MEASURES.

"The mode in which this Currant-worm has been transmitted, first from the European nursery to the American nursery, and afterwards all over several States of the Union, can be easily explained. As has been stated just now, it usually passes the autumn and winter in the ground under the bushes, where it has fed, housed in a little oval cocoon from $\frac{1}{4}$ to $\frac{1}{3}$ inch long. Hence if, as often happens, infested bushes are taken up in the autumn or early in the spring, with a little dirt adhering to their roots, and sent off to a distance, that dirt will likely enough enclose a cocoon or two. A single pair of cocoons, if they happen to contain individuals of opposite sexes, will be sufficient to start a new colony. The first and probably the second year the larvæ will not be noticed; but increasing as almost all insects do, unless checked from some extraneous source, in a fearfully rapid geometric progression, by the third or fourth year they will swarm, strip the bushes completely bare of their leaves, and ruin the prospect for a good crop of fruit. Of course, like other winged insects, they can fly from garden to garden in search of a suitable spot whereon to deposit their eggs; so that any point where they have been once imported becomes, in a few years, a new centre of distribution for the immediate neighborhood.

"Nurserymen and all others, importing Gooseberry and Currant bushes from a distance, should be particularly careful, before they plant them, *to wash the roots thoroughly in a tub of water, and burn or scald whatever comes off them.* Any cocoons, that may happen to be hidden among the dirt attached to the roots, will then be destroyed."

By adopting these precautions the dissemination of so mischievous a pest throughout the country, and especially its introduction into Missouri, might be prevented for many years to come.

REMEDIES.

White hellebore, which can be had at a comparatively low price, has proved an infallible remedy for this worm.

"All that is required is to dust it lightly over the infested bushes, taking care to stand to windward during the operation, as if taken into the nostrils it excites violent sneezing. For this purpose, the best plan is to put the powder into a common tin cup, tying a piece of very fine muslin over the mouth of the cup; or the powder may be simply

enclosed in a bag of muslin of convenient size. In either case, the apparatus must be fastened to the end of a short stick, so as to avoid coming in too close quarters with it. It is best to select a moderately still day for the operation; as the powder is so exceedingly fine that on a windy day it is apt to get wasted."

It may be more safely and agreeably, and just as effectually applied in solution, by syringe or sprinkler, in proportion of one pound of the powder to 20 or 25 gallons of water.

"To test the genuineness of the article, a very small pinch of it should be applied to the nose. If it is good and has not lost its strength by keeping too long, it will immediately produce a tingling sensation in the nostrils; if it does not produce this effect, it is worthless and should not be used. There is every reason to believe that in those cases where men have used White hellebore to kill Currant Worms without any preceptible effect, they had been deceived into buying an adulterated or worthless drug. Although, like almost all our medicines, hellebore, in large doses, is poisonous, yet in minute doses there is no reason to be afraid of it; for, according to Dr. Fitch, it has long been in use as the basis of those snuffs, which are designed to excite violent and continued sneezing."

The following interesting experience with hellebore in solution, and with hot water, is given by Mr. Saunders in the *Canadian Entomologist* (Vol. II, pp. 13–15), and will prove instructive.

The larva of *Nematus ventricosus*, alas, too well known under the popular designation of "currant-worm,"* has been very abundant in this neighborhood during the present season. In my own garden it has been a continual fight as to who should have the currant and gooseberry bushes, the worms or their rightful owner. During the early part of summer, anticipating their attack, I was on the lookout for them and by timely doses of hellebore, preserved the foliage with but little damage. In about a fortnight later, having omitted inspection for a few days, I was surprised to find the bushes being stripped again; and this time the enemy had got so far ahead as to damage their appearance considerably. Another prompt dosing of hellebore brought relief. After this I hardly ever found all the bushes entirely free from them; a walk around the garden would reveal a few here and a few there, and I was perpetually hand-killing and brushing off these smaller detachments. Four times during the season I found it necessary to apply hellebore freely, for the foes were a legion.

During the middle of August, being occupied with other matters, the garden was neglected for a few days, when on visiting it again on the 19th, I found many of the bushes entirely leafless, and the foliage remaining on the others was rapidly disappearing. I felt discouraged and began to have some misgiving as to whether hellebore was after all such an unfailing panacea for this almost universal pest as we had supposed. I resolved if possible to satisfy myself fully on this point, and having mixed about $1\frac{1}{2}$ oz. of powdered hellebore with a pail of water, was ready to proceed. I selected a leaf from two bushes, marked them and counted the number of their inhabitants—one was occupied by *forty-four* worms of different sizes, crowding it above and below, and it was about half eaten; the other leaf had twelve nearly full grown on it. Having transferred the mixture of hellebore and water to a watering pot, the bushes were sprinkled with it. I returned to examine the results in three-quarters of an hour, and the leaf which at first had forty-four on it, had now only two, and these were so far exhausted that they were unable to eat, and could hardly crawl,

* After this admission, it seems to me that the popular distinguishing term of "Imported Currant-Worm," first given it by Walsh, is preferable both to that of "Imported Gooseberry Saw-fly," given by Mr. Saunders (Rep. Ent. Soc. Ontario, 1871), and to that of "Currant Worm and Saw-fly" bestowed by Dr. Fitch.

while on the other leaf out of the twelve there remained three, but in the same enfeebled condition. All around under the bushes, the ground was strewed with the fallen foe, and I felt perfectly satisfied that entite reliance might be placed on this means of defense.

I did not anticipate such speedy action on the part of the hellebore, or should have returned to the examination sooner, and the bushes were so entirely cleared, that, excepting on one I had reserved for another experiment, I had no means of repeating the dose.

There was one thing that struck me as somewhat remarkable, the portion of leaf on which the greatest number were feeding, appeared to be of the same size as before the hellebore was applied; if smaller I could not perceive it. When the leaves dry, which have been sprinkled with liquid, a very thin coating of the powder, more or less regular, is found over them, and I had always supposed that death resulted from eating a portion of the leaf thus coated. Such is undoubtedly the case when the hellebore is applied dry, but in this case a meal however small made by *forty-four caterpillars* on half a leaf, must have materially diminished it. I am disposed to believe then that the death of most of these must have resulted from their imbibing or absorbing some of the liquid as soon as applied. Many of them showed symptoms of the violent cathartic action of the remedy, having a mass of soft excrement hanging to the extremity of their dead bodies.

I had reserved one bush, on which were a good number, for another experiment. It sometimes happens, especially with those who live in the country, that hellebore is not at hand when the worms are first observed at work, and a few days' delay in procuring it is perhaps unavoidable. In such cases the bushes may be entirely leafless, before the remedy can be applied. Hot water suggested itself to my mind as likely to be of some service, and being also an article readily procurable in every home. It is well known that many plants will bear such an application without injury, provided the heat is not too great. Taking some in a watering pot, a little hotter than one could bear the hand in, I showered it plentifully on the affected bush, and it was amusing to see how the caterpillars wriggled and twisted and quickly letting go their hold, fell to the ground, which was soon strewed with them. After the first excitement produced by the sudden heat was over, they remained as if wishing to "cool off" before commencing work again. A few did not recover from the application, but most of them were soon as acuve as ever.

Now what I would suggest is this, that where the hellebore cannot be at once procured, no time should be lost in applying the hot water, and when once on the ground the creatures may have the life trodden out of them by the foot, or beaten out with the spade or some other implement. In any case many of them would never reach the bush again, for enemies beset them on every side.

If used in powder, a perforated tin cylinder, such as is commonly used for the purpose in England, will be found useful to push into the bushes and reach every part thereof, and particularly the under sides of the leaves. It is generally made about $2\frac{1}{2}$ inches wide and 10 inches long. The cylinder has a fixed bottom, with a socket to receive a handle and a brace to strengthen the socket, and a tight-fitting cover completes it.

As the well known editor of the *American Agriculturist* writes from his own experience: "A pound of white hellebore, costing about forty cents, will clean any ordinary garden, and keep it clean for a season. If applied in the liquid form with a good syringe, the whole labor need not exceed an hour. There is great satisfaction in seeing clean bushes and clean clusters, and though it may be an evidence of depravity, we confess to a feeling of consolation at the sight of the enemy, stupefied, coiled up, and laid out in rows upon the brown earth. We always did have a private interpretation of Cowper's sentiment about 'needlessly setting foot on a worm.'"

Numerous other remedies might be detailed, some of which, as copperas water, decoction of poke weed root, etc., have doubtless proved

more or less effectual, but most of which are founded on isolated experiments and on results due to other causes which the experimenters did not understand. Indeed, one can scarcely pick up a horticultural journal without finding during the summer months some new remedy for THE Currant-worm recommended. But nothing equals those I have referred to, and even carbolate of lime, which is quoted by many authors as having been used with success by Dr. E. Worcester, of Waltham, Mass., and as being less disagreeable, less costly and perfectly safe, was, after thorough trial, found by Mr. Saunders, who is himself a chemist, and doubtless obtained the pure article, to be of little or no avail. The only manner in which it can be successfully employed, as Mr. M. W. Armington, of Providence, R. I., maintains, is by sprinkling it on the ground, and then shaking the worms down, when, if of full strength, it will prevent most of them from getting back.

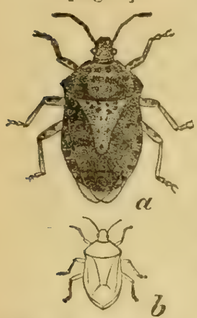
From the habit which belongs to this species of laying the eggs in large numbers on a single leaf, we can employ another means of counter-working its injuries which will not apply to the other two worms. The newly hatched larvæ can find "plenty of food without wandering off, and they have the habit when very young of boring small holes through the leaf, as shown at No. 2 in Figure 4, and when they become a little older, holes that are a little larger, as shown at No. 3. It is evident that such holes as these may be readily recognized, and the leaf be carried, larvæ and all, far away from any currant or gooseberry bushes, and left to winter there, or—to make assurance doubly sure—thrown into the fire. If, however, the young larvæ are removed a few rods away from any plant belonging to the botanical genus *Ribes,* they will be sure to die of starvation. For they cannot feed on anything else, any more than the common Locust-borer can live on an apple tree. As the eggs are laid in such large groups, there will be but a few leaves bearing these newly hatched larvæ to remove from every bush," and early in the season they will be found principally on the lower parts of the bushes, nearest the ground.

"Wherever this Currant Worm has been introduced, there has prevailed, from some cause or other, a popular superstition that the currants grown upon the infested bushes are poisonous. This is a mere delusion. They may be, and very probably are, unwholesome, just as any other fruit would be perhaps more or less unwholesome, if grown under such unnatural conditions as to seriously affect the health of the tree; but we have the authority of Dr. Fitch, himself a physician, for believing that the common notion on this subject is entirely erroneous."

NATURAL ENEMIES.

It is not probable that any of the natural enemies which attack this insect in Europe have been imported with it into this country; but several of our indigenous species have learned to prey upon it. Besides such indiscriminate feeders as ants and some of the cannibal beetles which Mr. Saunders has observed to attack the worms when they fall from the bushes, or are the least helpless or injured, it is attacked while on the bushes and in vigorous health by a Half-wing Bug, first noticed at this work by the same gentleman. This species (*Podisus placidus* Uhler, Fig. 7, *a*, enlarged; *b*, natural size) which may be called the Placid Soldier-bug, is marked with yellowish-brown

[Fig. 7.]



PLACID SOLDIER-BUG: *a*, enlarged; *b*, natural size.

and dark brown, and attacks the worms in the same well known manner in which the Spined Soldier-bug spears and sucks to death the larvæ of the Colorado Potato-beetle. Mr. Walsh bred from this Currant worm a small Ichneumon-fly (*Brachypterus micropterus*, Say) which has such small wings that it much resembles an ant. Mr. C. J. S. Bethune also reared from its cocoon another Ichneumon-fly (*Hemiteles nemativorus*, Walsh)* closely allied to that which infests our common Bag Worm (Rep. I, p. 150.) This same fly was captured a number of years ago by Mr. Walsh around Rock Island, Illinois, "and as the Imported Currant Worm has not as yet been introduced into that region, we must conclude that this Ichneumon-fly could not have been imported into America from Europe along with this Currant Worm, but that in all probability it is an indigenous species. Hence we have additional proof that, under certain circumstances, native American parasites can, and actually do, acquire the habit of preying upon European insects when the latter are imported into America. It is certain, however, that they will not do so in all cases without exception; for although the Wheat Midge, or Red Weevil, as it is incorrectly termed in the West, invaded our shores some forty or fifty years ago, not a single parasite has yet been discovered to prey upon it in this country, although there are no less than three that prey upon it in Europe."

Lastly, Mr. J. A. Lintner has discovered that even the eggs are inhabited by a minute Hymenopterous parasite which, I believe, remains undescribed; and he informs me that he has also bred a Tachina-fly from the larva.

* *Can. Entomologist*, II, page 9.

IT PRESENTS A FORCIBLE EXAMPLE OF ARRENOTOKY.

Parthenogenesis, or the production of offspring by virgin females, has long been recognised as a zoölogical fact, occurring with many of the lower forms of animal life, and not unfrequently with insects. With many of the latter, *e. g.*, the plant-lice, as we have so fully seen in these Reports in the case of the Grape Phylloxera, it is the normal form of reproduction; while with many other insects, as with some, and perhaps with most gall-flies (*Cynipidæ*), it occurs regularly at every alternate generation. It also occurs occasionally with insects which normally cannot or do not multiply without direct sexual intercourse, as in the common Mulberry Silk-worm. As I have remarked elsewhere:* "What in some species is the exception, becomes the rule in others, of which the hive-bee is an example. The male element may be said to possess all degrees of potency in its influence on the reproductive functions of its immediate issue, as the embryo in ova not directly fecundated, attains all degrees of development before death. In cases of parthenogenesis it is potent enough—vital enough, to cause full development of the offspring for one or more generations, though in the majority of instances, and especially where this mode of reproduction does not occur as a rule, this offspring is most frequently male." In other cases females instead of males are produced. The power possessed by the virgin females of certain species to produce male offspring, has been called Arrenotoky by Leuckart; while the parthenogenetic production of females has been designated as Thelytoky by Siebold, who has elaborately shown† that our Imported Currant Worm possesses the former power, and that the unimpregnated eggs hatch into larvæ which produce male flies. Further, that this is the rule with all its eggs non-impregnated, which seem to hatch fully as well as those which are impregnated. This power, as Siebold shows, had been observed as far back as 1831, by Robert Thom, who, in Loudon's *Gardener Magazine* (Vol. VII, p. 196), states, that "the ova of the female produce caterpillars, even when the male and female flies are kept separate;" but who, loth to believe in anything so extraordinary as *lucina sine concubitu* must have seemed in those days, thought that there was "reason to suspect that there is a connection between the male and female caterpillars," from the fact that these, as is so often the case with the Saw-fly larvæ, are not unfrequently found with their tails curled around each other. Thus arrenotoky occurs in our Currant Worm (Fam. *Tenthredinidæ*), as it does in the Hive-bee (Fam. *Apidæ*). It is also known to occur among wasps

**Am. Naturalist*, Vol. VII, p. 520.

†*Beitr. zur Parthenogenesis, &c.*, 106—130.

(*Vespidæ*). With certain moths belonging to the family *Psychidæ*, and with certain crustaceans, only thelytokic parthenogenesis takes place.

IT ALSO FURNISHES AN INTERESTING INSTANCE OF DEFUNCTIONATION OF SPECIAL PARTS.

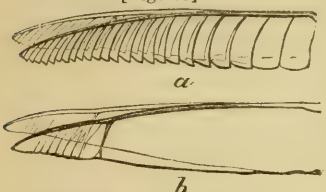
As already remarked (ante p. 8), the Saw-fly family to which our insect belongs, derives its name from the peculiar structure of the ovipositor, which looks like the blade of a saw.

"Under the microscope—and in the larger species, even under a good lens—it will be seen that the lower edge of each of the two horny blades, of which this instrument is composed, is furnished with very fine teeth, the shape of which differs in different species. With this tool the female fly saws into the texture of the leaf or of the twig, in which the instinct of each particular species teaches it to deposit its eggs; and—wonderful to relate—it was demonstrated long ago that the eggs thus deposited inside the substance of the plant, which is to supply the future food to the young larva as soon as it hatches out, actually grow and derive nourishment from the sap of that plant, so as often to attain double their original size.* Hence we may see at once why the eggs are deposited by this group of insects in such situations as these, and why Nature has provided the female Saw-flies with saws in their tails. But—as the thoughtful reader will perhaps have already observed—our Currant-worm Fly lays its eggs upon the surface, and not in the interior of the leaf, glueing them thereto by some adhesive fluid, which it secretes for that purpose." At the most in some instances, she scratches the epidermis. "And we may add that there are a few other Saw-flies—such for example as the Rosebush Saw-fly (*Selandria rosæ*)—which do the very same thing, and consequently, as well as our species, can have little use for any saws at their tails. If, therefore, as was formerly the almost universal belief of the scientific world, each species, whether of animals or of plants, was independently created, with all its present organs and instincts, and not derived, as is the more modern doctrine, from the gradual modification of pre-existing species through a long series of geological ages, we might naturally expect our Currant-worm Fly, and the Rosebush Saw-fly and such few other Saw-flies as practice similar modes of laying their eggs, to have no saws at all. For why should Nature, when she is creating new species, bestow an instrument upon a particular species which has no occasion whatever to use that instrument? In point of fact, however, all female Saw-flies, no matter what their habits

* I have already stated my opinion that this enlargement is not due solely to nourishment from the sap.

may be, possess these saws, though in one genus (*Xyela*) the saws, instead of being hard and horny throughout, are said to be soft and membranous above and below;* and in certain other Saw-flies, though they are as hard and horny as usual, they are degraded and—to use the technical term—'defunctionated.' This will be seen at once from an inspection of the following drawing (Fig. 8), copied by ourselves from nature and very highly magnified. Here *a* represents the two saws of the female of the Willow-apple Saw-fly (*Nematus salicispomum* Walsh), which belongs to the very same genus as our Currant-worm Fly. Now, we know that the female of the Willow-apple Saw-fly deposits a single egg inside the leaf of the Heart-shaped Willow (*Salix cordata*) about the end of April, probably accompanying the egg by a drop of some peculiar poisonous fluid. Shortly afterwards there gradually develops from the wound a round fleshy gall, about half an inch in diameter, and with a cheek as smooth and rosy as that of a miniature apple; inside which the larva hatches out and upon the flesh of which it feeds. In this particular case, therefore, as the female fly requires a complete saw with which to cut into the willow leaf, nature has supplied her with such saws, as is seen at once from Figure 8, *a*. Now look at Figure 8, *b*, which is an accurate representation under the microscope of the two saws of our Currant-worm Fly. It will be noticed at the very first glance that, although the blade of the saw is there, the teeth of the saw are almost entirely absent.

[Fig. 8.]



OVIPOSITORS OF SAW-FLIES :—*a*, perfect; *b*, imperfect.

What, then, are we to make of these and many other such facts? Manifestly the teeth of the saw are in this last species degraded or reduced to almost nothing, because the female fly, laying her eggs upon the surface of the leaf, and not cutting into the substance of the leaf, as does the female of the Willow-apple Saw-fly, has no occasion to perform any sawing process. But why, it will be asked, is the blade of the saw there in its normal size, and with the exception of the degradation of the saw-teeth, as completely developed as in the other species, when such a tool cannot be necessary for the simple process of glueing an egg on to the surface of a leaf? The modern school of philosophers will reply, that this is so, because the primordial Saw-fly, in the dim far-away vista of by-gone geological ages, had a complete pair of saws, and our insect is the lineal descendant of that species, slowly and gradually modified through a long series of years, so as to

*See Westwood's *Introduction*, II, p. 95.

conform more or less to the change in its habits. On the other hand the old school of philosophers, who believe that every species was independently created, will argue that this is so, in order to 'complete the System of Nature,' and 'carry out the Plan of the Creation,' and 'give full and free expression to the Thoughts of the Creator.' Possibly this may be the true solution of the difficulty; but—and we say it in no irreverent spirit—what should we think of a Potter, who made all his teacups, without exception, with handles; those for which handles were required with complete ones such as you could put your finger through, and such cups as were not wanted to have any handles at all, with solid unperforated ones, such as would be nearly useless? And what should we say, if the Potter's friends were to gravely argue, that he took all this unnecessary trouble in order 'to complete the System of Art,' and 'carry out the Plan of the Tea drinker,' and 'give full and free expression to the Thoughts of the Potter?'"

DESCRIPTIVE.

I repeat the following descriptions as originally drawn up by Mr. Walsh from many specimens, as the publications in which they occur are not now very accessible.

As I have already stated, the larva is pale green just previous to spinning its cocoon, having thrown off the tubercled skin with the last larval molt. Indeed this habit of throwing off the armed or ornamented larval skin before preparing for the pupa state is almost universal with the Tenthredinidæ. The comparatively naked condition, between the full grown larval and pupal states, may be likened to the semi-pupa state of some other insects, for the Saw-fly larvæ in this condition shrink somewhat in size and do not feed, as far as I have observed, though they may be active for a few days.

Nematus ventricosus—*Larva, nearly mature.*—Length ¾ inch. Pale green, verging on yellow towards the tail. Head black, polished, with numerous short hairs proceeding from minute tubercles. Mouth, except the mandibles, dingy green. Joints of the body above with rows of small shining black tubercles placed crossways, and each bearing a hair in the less mature specimens, but in the largest and most mature ones bearing no hairs at all, except the larger tubercles on the sides. First joint behind the head with a single row of dorsal tubercles; joints 2 and 3 each with a double row, the anterior one curved forwards in the middle in a semicircle; joints 4—12 with a treble row; the anal plate black, polished, and prolonged at each posterior angle in a slender acute thorn, and having, besides the triple row of tubercles before it, a group of six or eight tubercles on each side of and partly before it. A longitudinal row of larger lateral black tubercles on joints 2—12, one on each joint, beneath which there is a geminate black tubercle above each proleg; all these tubercles bearing many hairs. Legs black, the sutures pale green. Prolegs fourteen, pale green, all but the two anal ones with a few minute black dots towards their tip in front. Joints 4 and 11 without prolegs.

Female Fly.—General color of body bright honey-yello. *Head* black, with all the parts between and below the origin of the antennæ, except the tip of the mandibles. dull honey-yellow. Antennæ brown-black, often tinged with rufous above, except towards the base, and beneath entirely dull rufous, except the two basal joints; four-fifths as long as the body; joint 3, when viewed laterally, four times as long as wide. joints 3–5 equal in lenth, 6–9 very slowly shorter and shorter. In two females the antennæ are 10-jointed, joint 10 slender and ⅔ as long as 9. *Thorax* with the anterior lobe above, a wide stripe on the disk of each lateral lobe which is very rarely reduced to a mere dot, or very rarely the whole of each lateral lobe, a spot at the base and at the tip of the scutel, the two spots sometimes confluent and very rarely subobsolete, a small spot at the outer end of each cenchrus and a geminate small spot transversely arranged between the cenchri, the tip of the metathoracic scutel, the front and hind edge above of what seems the 1st abdominal joint, but is in reality the hind part of the metathorax, or very rarely its whole surface above, and also the whole lower surface of the breast between the front and middle legs, or very rarely two large spots arranged crossways on that surface, all black. Cenchri whitish. *Abdomen* with joints 1 and 2 very rarely edged at tip with black. Sheaths of the ovipositor tipped more or less with black, the surrounding parts sometimes more or less tinged with dusky. The triangular membrane at the base of the abdomen above, whitish. *Legs* bright honey-yellow; all the coxæ and trochanters whitish; the extreme tip of the hind shanks and the whole of the hind tarsi, brown-black. *Wings* glassy; veins and stigma brown-black, the latter as well as the costa obscurely marked with dull honey-yellow. In a single ♀ all three submarginal cross-veins are absent in one wing, and only the basal one is present in the other wing. In another ♀ all three are indistinctly present in one wing, and in the other only the basal one and a rudiment of the terminal one. In a single wing of two other ♀, the terminal submarginal cross-vein is absent. And in a single ♀ there are but three submarginal cells in either wing, precisely as in the genus *Euura.*—Length ♀ 0.22—0.28 inch. Front wing ♀ 0.27—0.33 inch. Expanse of wings ♀ 0.53—0.64 inch, (wings depressed).

Male Fly.—General color of body black. *Head,* with the clypeus and the entire mouth, except the tip of the mandibles, dull honey-yellow. Antennæ brown-black, often more or less tinged with rufous beneath, except towards the base; as long as the body, the joints proportioned as in ♀, but the whole antenna, as usual in this sex, vertically much more dilated, so that joint 3 is only 2½ times as long as wide when viewed in profile. *Thorax* with the wing-scales and the entire collare honey-yellow. Cenchri whitish. *Abdomen* with more or less of its sides, the extreme tip above, and its entire inferior surface honey-yellow. *Legs* as in ♀. *Wings* as in ♀. In two ♂ the middle submarginal cross-vein is absent in both wings, so that if captured at large they would naturally be referred to the genus *Euura.* In two other ♂ this is the case in one wing only. Another ♂ has but the basal submarginal cross-vein remaining in each wing. And in two other ♂ the terminal submarginal cross-vein is absent in one wing. Length ♂ 0.20—0.22 inch. Front wing ♂ 0.23—0.25 inch. Expanse of wings ♂ 0.44—0.54 inch, (wings depressed.)

"Described from 22 ♂ and 13 ♀, 3 ♂ and 1 ♀ of the spring brood. The fact of two ♀, contrary to the established character of the genus *Nematus*, having 10-jointed instead of 9-jointed antennæ is a variation of a kind of which no other example in the whole family of Saw-flies is on record. Had such a specimen been captured at large, instead of being bred along with a lot of normal ♀, from the same lot of larvæ taken from the same lot of bushes, it would probably have been made the basis of a new genus."

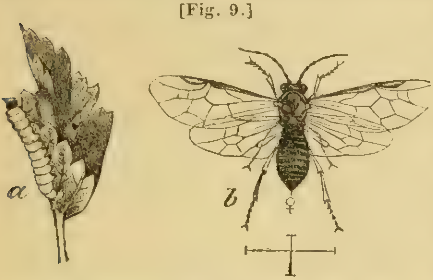
THE NATIVE CURRANT-WORM—*Pristiphora grossulariæ* Walsh.

[Ord. HYMENOPTERA; Fam. TENTHREDINIDÆ.]

WHEREIN IT DIFFERS FROM THE IMPORTED SPECIES.

"Like the Imported Currant-worm, this worm produces a Saw-fly, which, however, belongs to a different genus, (*Pristiphora*), chiefly distinguishable from the other one (*Nematus*) by the front wing lacking what is technically termed the 'first submarginal cross-vein.' In Figure 9, *b*, we give a magnified drawing of the female of this fly, and if the reader will look at this drawing and compare it with that of the Imported Currant-worm Fly (Fig. 6, *a* and *b*), he will see that there is in each of them but one cell, or 'pane' as it might be termed, on the upper edge of the front wing towards its tip. This is technically called 'the marginal (or radial) cell.' Now let the reader look a second time at these two figures, and he will see that, underneath this 'marginal cell' there is a tier of four cells in the one genus (*Nematus*) and a tier of only three cells in the other genus (*Pristiphora*), the first or basal cross-vein being absent or 'obsolete' in the latter, so as to leave the first or basal cell extravagantly large. These three or four cells, as they underlie the 'marginal cell,' are technically known as 'the submarginal (or cubital) cells;' and upon the difference in the number and arrangement of these marginal and submarginal cells depends to a considerable extent the generic classification of the Saw-flies. For example, in another genus (*Euura*), which is closely allied to the two of which we present drawings, there are, as in the second of these two, one marginal and three submarginal cells; but here it is the *second*, not the *first* (or basal) submarginal cross-vein that is obsolete; so that here it is the *second*, not the *first* (or basal) submarginal cell that is extravagantly large, being formed in this last case by throwing the typical second and third cells into one, and in the other case by throwing the typical first and second cells into one, just as by removing the folding doors two rooms are thrown into one.

[Fig. 9.]



NATIVE CURRANT-WORM:—*a*, larva, nat. size; *b*, fly, enlarged.

"Persons who are not familiar with this subject are apt to suppose, that the pattern of the curious network on every fly's wing varies indefinitely in different individuals belonging to the same species.

As a general rule, there is scarcely any variation at all in this matter, each species and even each genus having its peculiar pattern, and all the individuals belonging to a particular species having the network of their wings as exactly similar as the different photographs executed by a daguerreotypist from the same negative plate. You may take, for instance a thousand, honey-bees, and you will find that in the front wing of every one of them there are exactly one marginal and three submarginal cells, which, however, are all of them shaped very differently from the corresponding cells in any Saw-fly, though all the thousand honey-bees will be found to have them shaped exactly alike, cell corresponding to cell, as in any particular issue of $5 bank notes, vignette corresponding to vignette and medallion die to medallion die. Among the Saw-flies, indeed, as was noticed in the description of the Imported Currant-worm Fly, the pattern of the wing-veins in different specimens of the same species varies occasionally a little; but this is the exception and not the rule, and is philosophically of high interest, as showing how one genus may in the course of indefinite ages change gradually into another genus.

"The Native Currant-worm Fly differs in another remarkable point from the Imported Currant-worm Fly. The sexes are here almost exactly alike in their coloration, and with the exception of the legs of the male being a little more marked with black than those of the female, it would not be very easy to distinguish one from the other, but by the usual sexual characters. Hence we have not thought it necessary to give a figure of the male as well as of the female; whereas in the Imported species the two sexes differ so essentially in their coloration that, as already observed, a figure of one would give scarcely an idea of the other."

ITS HABITS.

"The larva of the Native Currant-worm Fly (Fig. 9, *a*) is of a uniform pale green color, without those black dottings which are always found, except after the last molt, in the Imported species. Before the last molt, indeed, the head is of a uniform black color, though it afterwards has a good deal of green in front; but the body remains throughout of the same immaculate green shade. It differs also in its habits from the Imported species, never, so far as we can find out, going underground to spin its cocoon, but always spinning that cocoon among the twigs and leaves of the bushes upon which it feeds.

"This species agrees with the other one in being double-brooded, the first brood of larvæ appearing about the end of June and the

beginning of July, and the second brood from the middle of August to the forepart of September. But instead of the larvæ of the second brood lying underground in their cocoons all winter, they burst forth in the fly state from the beginning to the middle of September. Hence the female fly is compelled to lay her eggs upon the twigs instead of on the leaves; for if she laid them upon the leaves, as is the habit of the Imported species, the second laying of eggs, which has to pass the winter in that state, would fall to the ground along with the leaves in the autumn, and the young larvæ would starve when they hatched out next spring before they could find their appropriate food. Consequently, in the case of this species, we cannot apply the method of counterworking the other species which has been already referred to. For we have particularly remarked that the very young larvæ were not gathered in great numbers upon one particular leaf—as with the Imported species—but were distributed pretty evenly over the whole bush. Neither did they bore the singular holes through the leaf (Fig. 4), which render the other species so easy of detection when young.

"As will have been observed from the figures given above, the Native species, besides the differences already noticed, is only about two-thirds the size of the other in all its states. Like the other, it infests both currant and gooseberry bushes, but appears rather to prefer the Gooseberry. Indeed there can be little doubt that our native Gooseberries formed its original food-plant; for many years ago we captured a single specimen in the nighborhood of Rock Island, Illinois, in woods remote from houses, where the wild gooseberry was pretty abundant, and there was no wild red currant." The species was described in 1866 by Mr. Walsh, "from numerous specimens found stripping the gooseberry and currant bushes in Davenport, Iowa; and it has since been reported to us by Miss Marion Hobart, of Port Byron, N. Illinois, as so abundant in her neighborhood in 1868 on the gooseberries as to completely defoliate them three times over, so that she inferred—but we think erroneously—that there were three distinct broods of them, one generated by another. Mr. Jas. H. Parsons, of Franklin, N. Y., has in a letter to us expressed the same opinion with regard to the Imported species. Probably both parties have been deceived by what is a very common occurrence with many leaf-feeding larvæ. There is often a warm spell early in the year which causes a moiety of the eggs of a particular brood to hatch out. This is taken for the first brood. Then follows a long spell of cold weather, which prevents the other moiety of the same batch of eggs from hatching out till perhaps a month or six weeks afterwards.

When at last the moiety does hatch out, it is considered by inexperienced persons as a distinct second brood. There is also very frequently a great variation, probably from similar causes, in the time at which the same batch of pupæ burst forth into the perfect winged state. For example, out of a lot of 31 cocoons, of the second brood of the Imported Currant-worm Fly, all received by us at the same time from Dr. Wm. M. Smith of Manlius, N. Y., most of the flies came out between June 26th and July 11th, but a few did not appear till towards the latter end of July and one lingered on till August 13th."

As I have captured the female fly in East St. Louis, and as worms which, from the description, could not well belong to any other species, were noticed by Mr. T. W. Guy, of Sulphur Springs, on his gooseberry bushes in 1870, there can be little doubt that the species occurs with us, as it is generally distributed throughout the country. Mr. L. D. Votaw of Eureka, has also reported to me the occurrence on his place of a "small green and unspotted worm" on his currant bushes.

REMEDIES.

The same as for the preceeding species.

DESCRIPTIVE.

I reproduce, from the *Practical Entomologist* (Vol. I, p. 123), Mr. Walsh's original descriptions, drawn up from many specimens.

PRISTIPHORA GROSSULARIÆ—*Immature larva.*—Length not quite reaching ½ inch. Body pale green, with a rather darker dorsal line, and a lateral yellowish line above the spiracles, the space below which line is paler than the back. Anal plate and prolegs immaculate. Head black, not hairy. Legs brown, except the sutures.

The mature larva measures ½ inch in length, and differs in the head being pale green, with a lateral brown-black stripe commencing at the eye-spot, and more or less distinctly confluent with the other one on the top of the head, where it is also more or less confluent with a large central brown-black spot on the face. The legs are also green, with a small dark spot at the exterior base of each, and a similar spot or dot before the base of the front legs.

Imago—♀—Body shining black, with fine, rather sparse punctures. *Head* with the entire mouth, except the anterior edge of the labrum and the tip of the mandibles, dull luteous. Labrum transverse and very pilose. Clypeus short, squarely truncate, immaculate. Antennæ ⅗ as long as the body, joint 3 three and a half times as long as wide, joint 4 fully ¼ shorter than joint 3, 5—9 very slowly shorter and shorter; brown-black above, beneath dull luteous, except joints 1 and 2, which are black, tipped below with luteous. *Thorax* with the wing-scales honey-yellow and the cenchri whitish. *Abdomen* with the basal membrane whitish; ovipositor honey-yellow, its sheaths black. *Legs* honey-yellow, or sometimes pale luteous, with the six tarsal tips of the tibiæ and of the tarsal joints 1—4, pale dusky. *Wings* subhyaline, tinged with dusky; veins black; costa honey-yellow; stigma dusky, edged all round with honey-yellow, especially below. In a single wing of two females only out of forty-nine, the first submarginal cross-vein, which in this genus is normally absent, is quite distinct; and in a

single wing of five other females, traces of it are visible on holding the wing up to the light. Length ♀ 0.17—0.21 inch. Front wing ♀ 0.19—0 23 inch. Expanse ♀ 0.41—0.45 inch, (wings depressed.)

The ♂ differs from the female only as follows: 1st. The antennæ are a trifle longer, and as usual vertically more dilated, joint 3 being only 2½ (not 3½) times as long as wide. 2d. The coxæ, except their tips, and the basal half of the femora, are black; and in the hind legs the extreme tip of the tibiæ and all but the extreme base of the tarsus, are dusky. Anal forceps honey-yellow. Length ♂ 0.17—0.18 inch. Front wing ♂ 0.17—0.19 inch. Expanse ♂ 0 35—0.38 inch, (wings depressed.)

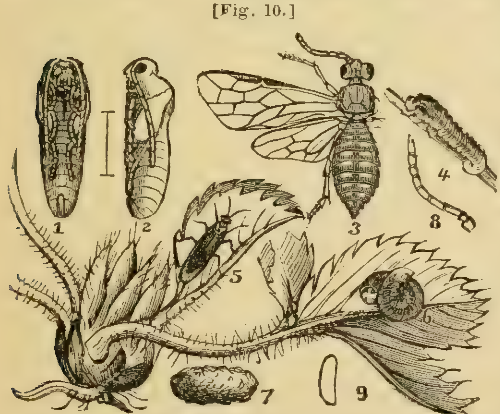
THE STRAWBERRY WORM—*Emphytus maculatus* Norton.

[Ord. HYMENOPTERA; Fam. TENTHREDINIDÆ.]

In connection with the foregoing account of the Imported and Native Currant Worms, it will be well to give the history and habits of a worm of the same family, which is the most conspicuous, if not the most common defoliator of that more profitable and more generally cultivated fruit—the Strawberry. This is the Strawberry Worm (*Emphytus maculatus* Norton) the natural history of which was first given by myself in the *Prairie Farmer* for May 25, 1867.

The species appears to have a wide range, as I have met with it in many parts of Illinois and our own State, have received it from Iowa, and it is reported from various sections in the East and from Ontario. In 1874, Prof. Bessey, of the Iowa Agricultural College, reported it as devouring the Strawberry plants in many parts of that State, and Mr. Hoffmeister, of Fort Madison, wrote me that in many sections the plants had to be plowed under in consequence of its devastations. Early in spring numerous flies, as shown in Fig. 10, *3* may be seen hanging to, and flying about the vines, in fields which have been previously infested. They are dull and inactive in the cool of the morning and evening, and at these hours are seldom noticed.

[Fig. 10.]



STRAWBERRY WORM: Ventral view of pupa; 2, side view of same; 3, enlarged sketch of perfect fly, the wings on one side detached; 4, larva crawling, natural size; 5, perfect fly, natural size; 6, larva at rest; 7, cocoon; 8, enlarged antenna, showing joints; 9, enlarged egg.

They are of a pitchy black color, with two rows of large, transverse, dull, whitish spots upon the abdomen. The female, with the saw-like instrument peculiar to the insects of this family, deposits her eggs by a most curious and interesting process, in the stems of the plants, clinging the while to the hairy substance by which these stems are covered. The eggs are white, opaque, and 0.03 of an inch long, and may be readily perceived upon splitting the stalk, though the outside orifice at which they were introduced is scarcely visible. They soon increase somewhat in bulk, causing a swelling of the stalk, and hatch in two weeks—more or less according to the temperature—and during the early part of May the worms attract attention by the innumerable small holes they make in the leaves. Their colors are dirty yellow and gray-green, and when not feeding, they rest on the under side of the leaf, curled up in a spiral manner, the tail occupying the center, and fall to the ground at the slightest disturbance. After changing their skin four times they become fully grown, when they measure about $\frac{3}{4}$ of an inch.

At this season they descend into the ground, and form a very weak cocoon of earth, the inside being made smooth by a sort of gum. In this they soon change to pupæ, from which are produced a second brood of flies by the end of June and beginning of July. Under the influence of July weather, the whole process of egg depositing, etc., is rapidly repeated, and the second brood of worms descend into the earth during the forepart of August, and from their cocoons, in which they remain in the caterpillar state through the Fall, Winter, and early Spring months, till the middle of April following, when they become pupæ and flies again, as related.

REMEDIES.

The same remedies recommended for the Currant Worms will apply here. They are more satisfactorily employed, however, and after the worms have been made to fall to the ground, a mixture of warm water and kerosene will destroy them as quickly as anything.

DESCRIPTIVE.

Emphytus maculatus:—*Imago.*—Color piceous, with two rows of dull, dirty white, transverse spots upon the abdomen. Wings hyaline; veins black; eyes and eyelets black; antennæ black and 9-jointed. Legs brown and almost white at the joints. No particular difference of coloring in the sexes. Average expanse of female 0.53 inch; length, exclusive of antennæ 0.24 inch.

Larva—Length 0.60—0.65 inch when full grown, having changed but little in appearance from time of birth. Somewhat translucent. General color, pale, dirty yellow, with a glaucous shade along dorsal and sub-dorsal regions, inclining in most cases to deep blue green on the thoracic segments. Minutely wrinkled transversely. Venter light glaucous. Legs—6 pectoral, 14 abdominal, and 2 caudal—of the same

color. Head of a more decided yellow than body, with usually a dark brown spot above, one nearly of the same size at the upper front, and two rather smaller ones at each side—joined by a brown line—the anterior spot being lower down than the other. In certain specimens these two are blended, and there is but a triangular spot on the top of the head, while the depth of shading on the body is also variable.

Pupa—Of a dingy, greenish-white color, the members being somewhat paler than the body.

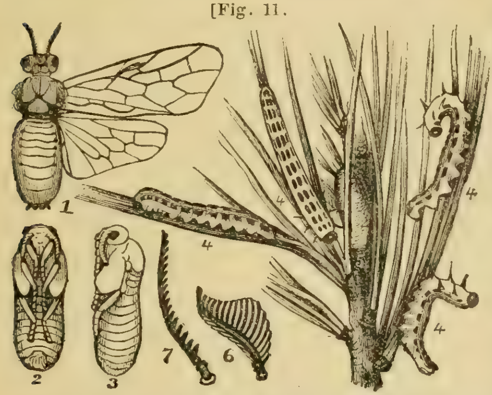
Numerous specimens in all states examined.

ABBOT'S WHITE PINE WORM—*Lophyrus Abbotii* Leach.

[Ord. HYMENOPTERA ; Fam. TENTHREDINIDÆ.]

Belonging to the same Saw-fly family as the preceding species, are certain false-caterpillars which are very injurious to pines. They belong to the genus *Lophyrus*, so named from the plume-like antennæ of the males. In Germany whole forests of pine and fir trees have been destroyed by insects of this genus, and D. E. Miller has published a large volume on the depredations of four species which destroyed thousands of acres of pines in Franconia. Two species more particularly occur in the Mississippi Valley, and the one under consideration is the most injurious of the two. The habits and transformations of both were first partially made known by myself some ten years since (*Prairie Farmer*, Nov. 10, 1866, May 25, 1867, May 2, 1868, and P. F. Annual, 1869), and are more fully given herewith.

[Fig. 11.



ABBOTT'S PINE WORM: — Perfect fly magnified; the left wings removed; 2 and 3, enlarged pupæ; 4, larvæ in different positions, natural size; 5, cocoon natural size; 6, magnified antenna of male; 7, magnified antenna of female.

Abbot's White Pine Worm has been more frequently sent to me, with complaints of injury, from Indiana and Illinois. Yet it occurs over a wide extent of country, and in the columns of the *Rural New Yorker* and *American Agriculturist* frequent records of its injuries in the East are to be found of late years. While its injuries are reported from the northern part of Missouri, it seems not to occur in the southern part of the State.

The following passage from a letter received from Mr. Jos. T. Little, of Dixon, Ills., in 1869, gives a very good account of the working of the insect:

I find them on one clump of pines on my lawn, and in a small lot of pines in my nursery. Late last Fall, I discovered that those same trees had been attacked by some worm or other, and that the foliage had been stripped off the young shoots, which shoots dried up this Summer. We had a very hard freeze on the night of October 8th, the mercury being at 30 degrees above zero; but still the worms do not seem to be affected by the weather. They are very sluggish at any time in their movements. I have Scotch and Austrian Pine, Arbor Vitæ, Balsam Fir, Norway, Spruce and Red Cedar, in the immediate vicinity of the White Pines, but they are unmolested.

In 1872 Mr. A. W. Barber of Lancaster, Wis., lost some fine trees by its injuries, and it was complained of in many sections the past year. This worm, which is dingy white in color, with black head and black spots (Fig. 11, *4 4*) has, in every instance that has come to my knowledge done its principal injury late in the Fall, and may frequently be seen feeding into November, or after the ground is frozen about an inch deep. When full-fed, these larvæ enclose themselves in oval, bright bronze, or gold-colored cocoons, spun up between the needles, or in whatever sheltered situation is at hand. Sometimes the cocoon is formed upon the tree, but more often among the fallen needles and other debris and shelter beneath it. Within these cocoons the worm is very tightly packed, and remains till toward the following Spring, or even late Summer, when it becomes a pupa, with a dusky dorsal line and pale brown eyes (Fig. 11, *2*, *3*). The flies issue two weeks afterwards, and the sexes differ so much that they would be declared distinct insects by the uninitiated. The male, with the exception of the underside and tip of the abdomen, is jet black, his average length 0.23 inch, and the expanse of his wings, 0.47 inch. The female measures 0.30 inch, and expands 0.65 inch. She is of a honey-yellow, with the head and thorax somewhat darker than the abdomen; the thorax blackish at the upper posterior sides, and the abdomen having a lighter lateral stripe, with four or five blackish spots above it. These distinguishing features are much more striking in the living, than in the dried cabinet specimens. The antennæ in both sexes are black, those of the male 21-jointed and with 17 long and 17 shorter plume-like branches: those of the female serrated, with one or two joints less than the male, and 17 serrations.*

*Fitch, in the brief and summary account given of *L. Abbotii*, says that the antennæ are 17-jointed; while another species, which he named *L. Lecontei*, and which he supposed was the parent of worms, the description of which answers perfectly to the above, he says, has 21-jointed antennæ. I have examined dozens of *L. Abbotii*, and the antennæ are usually 21-jointed in the ♂, and 19-jointed in the ♀, counting the scape or bulbus as 2, and the terminal enlargement as 2. In reality, however, the terminal joint frequently appears single, and the number of joints is found to vary in different individuals in the same species, when large material is examined. In *Abbotii* I have individuals with antennæ having 18, 19, 20 and 21 joints respectively; in *Abietis* the number varies from 21 to 23 in ♂, and from 14 to 18 in ♀, and in *LeContei* they are usually 21 in ♂ and 19 in ♀—always counting the scape as 2.

Abbotii and *LeContei* cannot, therefore, be distinguished by the joints in their antennæ, as, with others, I myself once believed they could, and the relative number of antennal joints in this genus loses all specific value.

The eyes and eyelet are black, and the legs pale rufous in both sexes; while the wings are hyaline with prismatic colors. In escaping from the cocoon, the fly makes a clean, somewhat spiral cut at one end, always leaving a small hinge for its prison door to swing on.

These flies, in confinement, soon die without ovipositing, which indicates that they nourish on something out-doors. As with most saw-flies, the perfect insects are quite irregular in coming out of the ground, many of them issuing in May, but others not till toward the end of Summer. On opening cocoons that had passed the Winter I have found many yet containing the larva the latter part of June, while others of the same brood had become flies six weeks before. The species has generally been considered single-brooded; but as I have had the eggs laid as early as May, and the young worms feeding the latter part of that month, two broods are not improbably produced. In ovipositing, the female saws beneath the epidermis on one of the flat sides of the leaflet and pushes into the slit an egg, which is whitish, ovoid, 0.8 m.m. long on an average. As the egg swells it forms a conspicuous bulging of the epidermis, and the mouth of the slit opens and exposes more and more a portion of the egg. The young worm has the black head and black-ringed thoracic legs of the full grown individuals, but otherwise differs essentially from them, the body being uniformly pale and unspotted. The worms are more or less gregarious throughout their existence, and seldom leave a twig or branch till they have completely stripped it. Inconspicuous at first, they are seldom noticed till the denuded branches attract attention, and when, after the last molt, they strip a tree with astonishing rapidity. They have a habit of throwing back the head and tail when disturbed, and if violently shaken many of them will fall to the ground. They also use the tail end of the body to grasp more firmly the leaflets upon which they feed. This is the worm described by Fitch as the possible larva of *Lophyrus LeContei*, and the real larva of this last will be described further on.

NATURAL ENEMIES.

The reason that this Pine-worm abounds at times and then suddenly disappears, is that it is extensively preyed upon by a parasitic Ichneumon fly, belonging to the genus *Limneria*. The species, which I have also bred from some wax-feeding larva (probably *Ephestia zeæ*) does not fully accord with any of the descriptions of Norton, Cresson, or Provancher. I therefore briefly define it herewith:

LIMNERIA LOPHYRI, N. Sp.—♀, length 0.30—0.35 inch. Head and thorax black with silvery white pile. Antennæ piceous, more than half as long as body; but slightly paler toward tip; bulbus either yellowish or rufous. Ocelli either rufous or black. Mandibles, palpi, front and middle coxæ trochanters and tibiæ, pale yellow. Tegulæ almost white. Abdomen, with faint pile, rufous, the petiole and sides of next joint usually blackish. Hind legs rufous, the base of tibiæ and of tarsi paler.

♂ somewhat smaller, and with more black on the abdomen.

Four ♂'s, 12 ♀'s bred from larvæ of *Lophyrus Abbotii.*

REMEDIES.

As evergreens suffer more from defoliation than deciduous trees, it is essential, during the proper season, to scan them very closely every few days where this insect is known to prevail. When the worms are noticed, a syringing of hellebore water, or a dusting of fresh air-slacked lime, while the tree is bedewed, will destroy them. Care should be taken to prevent their injuries by clearing the ground around the trees late in the Fall, and burning the fallen needles and rubbish, with such cocoons as may be among them.

DESCRIPTIVE.

LOPHYRUS ABBOTII:—*Larva*—Average length 0.80 inch, though many will measure about an inch. A soft, dingy, white worm, having often a greenish or bluish line superiorly. On all joints but the first, which is entirely white, two oblong square black spots along the back, and another somewhat rounder spot each side. These become somewhat diffuse on the three latter joints, forming on the last a single black patch. Three black thoracic legs, fourteen abdominal, and two caudal prolegs. Thoracic joints largest; the three last, smallest and tapering. Some are marked very regularly, while in others the white space on the back between the spots on joints 5, 6, 7 and 8, is much wider than between the others. This is probably sexual difference, since those thus marked are shorter, thicker, and of a yellower white than those regularly marked. After each change of skin the head is at first white like the rest of the body, with the usual eye-spots black. No markings while young.

LE CONTE'S PINE WORM—*Lophyrus LeContei* Fitch.

[Ord. HYMENOPTERA; Fam. TENTHREDINIDÆ.]

Abbott's Pine Worm shows great preference for the White Pine and is seldom found on any other. It is, moreover, the most common and destructive species of the genus in our part of the country. LeConte's Pine Worm is, on the contrary, a more general feeder and prefers the coarse-leaved pines, such as the Austrian, Scotch and Pitch.

It is also most abundant in the East. It was first sent to me in October, 1867, by my friend A. S. Fuller, present editor of the *Rural New Yorker,* with the following letter.

I send you by to-day's mail a box of caterpillars found feeding on the Scotch and Austrian pines in my nursery. I can find nothing in Fitch or Harris which will enable me to identify them. These caterpillars have appeared in myriads in the last few weeks, and they do not pass a leaf, but take them all clean, old or young. If you can tell me all about this worm, please do so.

In a recent article (*R. N. Y.*, Nov. 25, 1876) referring to the injuries of what is evidently the same worm, though confounded with the preceding, Mr. Fuller writes:

We have already had some pretty hard frosts up to this date, Nov. 14, and yet a neighbor has just brought us some of these grubs taken from his pine trees. For several years past we have noticed that these Saw-fly larvæ remained upon the trees till very late in the Fall, and that it required a hard freeze to make them leave off feeding and descend to the earth, where they spin their cocoons among the old leaves and other vegetable matter.

These two pine worms have precisely similar habits, and, though bearing so close a resemblance to each other as to be easily confounded, LeConte's species is easily distinguished upon close examination by having the head reddish-brown, the spots differently shaped, and an extra row on each side. The female fly is distinguished by her black abdomen. For those interested the differences are presented more in detail in the following descriptions:

DESCRIPTIVE.

LOPHYRUS LECONTEI:—*Larva*—Average length, when full grown, about one inch. Color, dingy or yellowish-white, and void of any greenish or bluish hue. Dorsal black marks wider anteriorly than posteriorly, and usually broken transversely in the full grown individuals; also further apart than in *L. Abbotii.* Lateral spots sub-quadrate, with an additional row of smaller black marks below them. Head shiny reddish-brown, with black eye-spot each side. Jaws tawny. Anal joint entirely black above. Venter and prolegs (14 abdominal and 2 anal) immaculate. Thoracic legs black, with white joints. When young it is without marks, and some of the full-grown specimens have them more distinct than others.

Pupa—Undistinguishable, except in the average larger size, from that of *L. Abbotii.*

Imago—The male fly can scarcely be distinguished at first sight from that of the other species, though the average size is somewhat greater, and the brown parts, viz.: venter, and tip of abdomen above, are of a somewhat deeper rufous-brown. The antennæ are more often and regularly 21-jointed than in *Abbotii.*

The female is distinguished, however, by her body being jet black above, except a small brown patch at the extremity and a transverse line of the same color just below the thorax; and by her wings being smoky instead of hyaline. Venter with a black longitudinal line, more or less intense, each side. Thorax and head as in *Abbotii*, if anything, a little deeper in color. Average length 0.40, and expanse 0.70, though some will measure 0.50 inch and expand 0.82 inch.

There are several other American Saw-flies belonging to the same genus (*Lophyrus*) whose larvæ doubtless feed upon evergreens. One (*Lophyrus abietis* Harris) which is treated of by Harris, depre-

dates more particularly on the Fir, and, as a worm, is at once distinguished by being green, with darker green lines, but no spots, and by making a grayer cocoon. The larvæ of *Lophyrus Americanus* Leach, *L. Fabricii* Leach, and of *L. compar* Leach are unknown, and I suspect that some of these supposed species will prove to be but varieties of the three whose habits are here recorded.

THE COLORADO POTATO-BEETLE.

In some parts of Iowa, Wisconsin and the Northwest, this insect was very troublesome again the past year, but from one cause and another, though principally on account of the wet character of the past two summers, it attracted little attention in Missouri and the larger part of the Mississippi Valley. Yet on the Atlantic, and especially in the New England States, it has been a most fruitful theme of discussion and a constant object of warfare: nor have its doings ceased to interest Europeans. A pretty full record of its movements and of the more important and practical topics connected with it, has been published by me from year to year, and quite a demand has been made for back copies of these Reports from people in the East, and even from Europe. The editions of the earlier Reports, which contained most information on the subject have long since been exhausted, and in order to satisfy the demand, I prepared last Fall a small work entitled "Potato Pests," in which, with other insect foes of the Potato, the Colorado Potato-beetle is treated of at length. The work is published by the Orange Judd Co., of New York, and what I have to say below is mostly taken from it, and will serve to complete and complement what has previously been published in these pages.

SPREAD OF THE INSECT DURING THE YEAR.

During the past year, 1876, the insect has swarmed in most of the New England States, and especially on the sea shore. It has extended north around Montreal, and was especially abundant as far as Trois Rivières;* while in its eastern progress it has overrun Con-

* L. Provancher in *Naturaliste Canadien*, Aug. 1876, p. 249.

necticut, Massachusetts, Vermont and New Hampshire and extended some distance into Maine. At Milestone and other places in Connecticut the beetles were washed ashore in such numbers in September as to poison the air, and the captain of a New London vessel found that they boarded him in such numbers while at sea that the hatches had to be closed. At many watering places, such as Cape May, Coney Island, Long Branch, Rockaway and Newport, they proved a great nuisance, being crushed and killed in large numbers by the continual promenading along the beach. The New York *Times* reported their impeding the progress of a train on the Central Railroad at Grinnell Station: "the rails were covered with them for a mile, and after a few revolutions of the drivers the wheels lost the friction and slipped as if oiled; *** they had to be swept off, and the track sanded before any progress was made."

The following items will further convey a good idea of the prevalence of the pest along the coast:

A day or two ago a party of gentlemen fishing near the middle of Long Island Sound, saw great quantities of potato bugs covering the surface of the water as far as the eye could reach. Every floating article, as well as the water, was packed with them, and many were clinging to eel-grass and sea-weed under the water. The wind was blowing from the south, and had probably carried them from the island, and they were being wafted toward the Connecticut shore. Inland on the island the bugs appear to be increasing in numbers, and, the potato vines being dry, they have attacked the egg-plants, pepper plants, and tomato vines.—[Correspondence of *N. Y. Tribune* from Huntington, L. I.

The sea coast in the vicinity of this city and the shores of Long Island Sound are, at the present time, undergoing invasion by countless myriads of potato bugs. Where the insects come from is a mystery. They seem to cling to the floating sea weed and are left therewith on shore by the tide. At Coney Island and other points directly on the ocean, the bugs are most numerous, showing that they have been brought hither by sea currents, and by similar means have been swept into Long Island Sound. It seems hardly possible that the insects will now fail to reach the other side of the Atlantic, as they may find transportation on vessels, or be carried over in the drifting weed of the Gulf Stream.—[*Scientific American*, Aug. 5, 1876.

While at Atlantic City, N. J., last Saturday, I noticed great numbers of the Colorado Potato-beetle flying about on the beach. I have never seen them so active before. Their unusual activity there may be the result of hunger, as there is an entire absence of the Solanaceæ, either wild or cultivated, in that vicinity.—[From a letter from G. W. Letterman, Allenton, Mo., July 22, 1876.

There were twice as many potato-beetles as all other kinds put together. They evidently had been eastward bound, dropped into the ocean, and were brought back by the returning waves. We may infer also that many never reached the shore again from which they had made their departure, but were gobbled up by the fishes that sometimes plentifully inhabit those waters. Nor is this all: some distance up the Bay, and nearer the town of "Lewes," there is a tressel work—called the "Pier"—which extends a quarter of a mile out into Delaware Bay, upon which is a railroad track, upon which the cars of the Junction Railroad daily run to discharge their cargoes into sailing vessels and steamboats that periodically leave the outer end of the pier for New York, Philadelphia, Boston, Baltimore and other points. In the morning and the evening, when less commercial activity reigns, the pier is esteemed a capital place to fish. Well, all along this pier, from the shore to the extreme outer end, the ubiquitous potato-beetle was present, and at the outer end far more numerous than nearer shore. The State of Delaware at the time was full of these beetles, from one end to the other. The fruit-growers were shipping their peaches to market, and every cargo brought down from the interior also brought down a goodly number of the beetles, and it is

[Fig. 12].

SPREAD OF COLORADO POTATO-BEETLE.

not at all surprising that they should be carried aboard of the waiting vessels, and transported to other parts of this country, if not to Europe.—[S. S. Rathvon, in *Lancaster Farmer*, Aug. 1876.

RATE AT WHICH IT TRAVELED.

Walsh estimated, from the rate at which it traveled in the earlier history of its march, that it would reach the Atlantic in 1881. From subsequent calculations I placed the date at 1878, but it in reality touched the Atlantic seaboard at many different places in 1874. It thus spread at an average annual rate of about 88 miles. But the annual rate was by no means uniform. Earlier in the history of its march the rate was much lower, and until it got east of the Mississippi, did not average fifty miles. A glance at the accompanying map (Fig. 12) will suffice to show that the line of most rapid spread was along the line of greatest human travel and traffic. In fact, after it had reached New York it began to extend and swarm both north and south along the coast, before many of the inland counties on similar parallels were reached by the main line of the immense army.

HOW IT TRAVELED.

As the larva is sluggish and never leaves the plant from which it is hatched, except in quest of more food, until it is ready to pupate, all the journeys of this insect are necessarily made in the perfect or beetle state by means of the ample rose-colored wings, which, when the insect is at rest, are compactly folded up beneath the striped wing-covers. Its spread, however, over the more populous portions of the country, is not to be attributed to its powers of flight alone. It undoubtedly availed itself, to no inconsiderable extent, of every means of transportation afforded to other travelers, and often got a lift on eastern bound trains, and most probably crossed the more barren plains bordering its native confines through man's direct agency, i. e. by being carried. There is a possibility that in some instances it may have been carried in the egg state on living plants, or in the pupa state in lumps of earth; but these modes of transit, if they have occurred at all, have necessarily been exceptional. Even the winds and waters aided its progress. Its invasion of Canada, for instance, took place at precisely the two points where we should expect to first meet with it in the Dominion, namely, near Point Edward, at the extreme south of Lake Huron, and opposite Detroit, near Windsor, at the southwestern corner of Lake St. Clair; for all such beetles as fly into either of the lakes from the Michigan side, would naturally be drifted to these points.

Many insects that are subject to very great multiplication, though not naturally migratory, often acquire the habit of migrating in

swarms from one part of a country to another; and the migrating tendency has at times been quite marked in our Doryphora during its eastward march. This tendency is particularly noticeable in the last or Fall brood, and I have seen the beetles in autumn, swarming in the air or traveling in immense armies on foot—all instinctively taking the same direction, which is indeed a peculiarity of all animal migrations. There can be little doubt, therefore, that the larger areas have been traversed by this insect in the latter part of the growing season.

AREA INVADED BY IT.

From the foregoing account it is manifest that this pernicious beetle has spread over an area of nearly 1,500,000 square miles, or considerably more than one-third the area of the United States. It has traveled over two-thirds of the continent in a direct eastern line, and at least 1,500 miles of this distance since 1859. It occupies at the present time, more or less completely, the States of Colorado, Nebraska, Kansas, Minnesota, Iowa, Missouri, Wisconsin, Illinois, Michigan, Indiana, Kentucky, Ohio, New York, Pennsylvania, District of Columbia, Virginia and West Virginia, Maryland, Delaware, New Jersey, Connecticut, Rhode Island, Massachusetts, Vermont, New Hampshire and Maine, in none of which it was autochthonous, except the first mentioned. If we wish to outline the whole territory now occupied by it, we must add to the above, parts of Wyoming and Dakota, where it was native, a large portion of Canada and limited portions of N. Carolina, Tennessee, Arkansas, Indian Territory, Texas and New Mexico. The map given on page 36 (Fig. 12) tells the story better than any words I can employ.

CAUSES WHICH LIMIT ITS SPREAD.

There are reasons why the Colorado Potato-beetle did not spread as rapidly along the line of its southern as along that of its northern march. The first is, that the potato is not in such general cultivation along the latter as along the former parallel, and potato fields are, therefore, more scattered; the second, that the insect was northern rather than southern in its native habitat; the third, that it suffers and does not thrive where the thermometer ranges near 100° F. The larvæ frequently perish under such a broiling sun as we sometimes have at St. Louis, and during very hot, dry weather, it frequently fails, as it did in 1868, to successfully go through its transformations in the ground, which becomes so hot and baked that the pupa dries out, and the beetle, if it succeeds in throwing off the pupal skin, fails to make its way to the surface. For these reasons it may never extend its range very far south of the territory now occupied. Its northern spread is not limited by any such cause, and the intensity or length

of the winter will hardly affect it, except in reducing the number of possible annual broods, and consequently its power of multiplication. The state of dormancy once entered into may continue a month or two, more or less, without seriously affecting most insects. We may expect, therefore, to see it push to the northernmost limit of the potato-growing portion of the country—a limit which it has already well nigh reached.

The question whether it will extend farther westward and reach the Pacific, is a more interesting one. There is the best reason for believing that the Rocky Mountains furnish an impassable barrier to it, as they do to so many other insects. It has already been shown (Rep. 7, p. 2) how potatoes in the mountains were for years less affected than were those of the Mississippi Valley; but that in 1874 the insect proved quite injurious to those of the mountain region of Colorado. The fact is well established that it has not reached more than three or four miles into the mountains, or to about the middle elevations—say 8,000 feet above the sea level. The reason is that the atmosphere above that level is so dry and attenuated that, taken in connection with the cool nights, the eggs, or the larvæ that succeed in hatching from them, shrivel and dry up. We have here, therefore, a physical barrier to its further westward progress, and the beetle is no more likely to reach California without man's direct assistance and carriage than it is to cross the Atlantic Ocean without the same means. Whether it could thrive on the Pacific Coast, where the summers are so dry, is another question; but I fear it would hold its own, in many portions, if once introduced. In this connection it will be well to state that geographical races of *Doryphora* 10-*lineata*, differing in no very important characters from the typical northern specimens, occur in S. Texas, New Mexico, Arizona and Mexico, though they seem to have no more acquired the potato-feeding habit than the *D. juncta* has done.

HOW IT HAS AFFECTED THE PRICE OF POTATOES.

During the earlier years of the insect's devastations in the Mississippi Valley, it materially affected the price of potatoes, not only by its direct ravages, but by discouraging farmers from attempting to cultivate the crop on an extensive scale. In 1873 the price reached the high figure of $2.00 per bushel (wholesale) in the St. Louis market, and many a family had to forego the luxury of a product which a few years before had been one of the cheapest of the farm, and so abundant as to enter largely into the feed of all kinds of stock. At the present time, with the improved methods of fighting the enemy, there is no longer the same dread of it in the Western States that formerly

existed: its management is considered part of potato-culture, and its natural enemies assist man to that degree that its effect on the crop is less felt. The quality of the tuber was very seriously affected through the defoliation which the vines so generally endured, and it was at one time difficult to get a non-watery potato on our western boards.

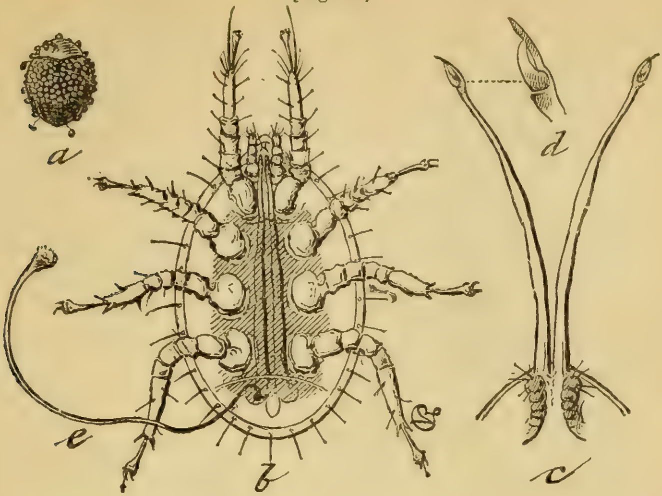
THE MODIFICATION IT HAS UNDERGONE.

In previous Reports I have, from year to year, shown how the species, as it spread over the country, became modified in habit, and increased the number of its food-plants. It has also undergone considerable modification in character. Specimens which I have examined from different parts of the country, show great variation in the marks of the thorax, in size, in coloration, and even in the ornamentation of the elytra and legs. The yellow varies from deep gamboge to almost pure white, the black line along the elytral suture is either very distinct or as obsolete as in *juncta;* while some specimens have the pale legs and the femoral spot, more or less distinct, which are so characteristic of this last. In northern Iowa and Wisconsin I have seen millions traveling over the ground, the average size of the individuals being not more than half that of the more typical specimens; and the general ground-color being white rather than yellow. In its southern range the colors tend to brighten and the black to become more metallic. Indeed, the variation which it has already exhibited furnishes interesting material for the close species makers.

AN ADDITION TO ITS NATURAL ENEMIES.

Among the many different enemies of this potato depredator that I have treated of, only one true parasite (*Lydella doryphoræ*) was, up to 1876, described, and that an internal one. In the summer of 1873, Mr. H. C. Beardslee, of Paynesville, Ohio, sent me a mite with which he found Doryphora attacked, and last summer this same mite was found by Mr. W. R. Gerard, to very generally infest the beetles around Poughkeepsie, N. Y. It sometimes so thickly crowds and covers its victim that no part of this last is exposed, and the beetle thus infested languishes and eventually perishes. This minute parasite is about the size of the head of a small pin, broadly oval, depressed, the body in one piece, somewhat tough above, and yellowish-brown in color. It is not uncommon on other beetles, and is closely allied to a well known European mite parasite of beetles and other Articulates—the *Uropoda vegetans.* This last is described by authors as possessing the peculiarity of attaching itself to the hard, shelly parts of its victims by means of a thread-like filament that issues from the posterior part of the body. A careful study of our American

[Fig. 13.]



UROPODA AMERICANA:—*a*, Colorado Potato-beetle attacked by it—nat. size; *b*, the mite, ventral view, and showing the penetrating organs lying between the legs; *c*, the organs extended; *d* the claw; *e*, the excrementitious filament—all greatly enlarged.

species has convinced me that the similar anal filament, which also helps it to adhere to Doryphora, is in reality excrementitious, sticking to the beetle and to the mite by a flattened disc at either end—being quite fragile and easily broken. The true penetrating organs, which enable the mite to hold tenaciously to its victim, and doubtless assist in obtaining nourishment, I have discovered to be a pair of extensile processes, each armed at the tip with a bifid claw, somewhat resembling that of a lobster. When at rest these organs are retracted and lie between the legs and just under the skin. When extended, they are usually brought closely together and extend the whole length of the animal beyond the head. They seem to be thrust forward by a series of muscles at the base, and I have frequently seen one extended while the other remained retracted. Thus, in addition to the more frail excrementitious and adhesive filament, this *Uropoda* is provided with an organ that is beautifully adapted to penetrating the hard covering of beetles, and of thus securing it to its slippery support.*

* As will be seen by the figure, these organs in repose extend so far back toward the anus that it is difficult to believe that they compose part of the mouth structure. Yet in carefully studying them I felt convinced that they were maxillæ, or rather the homologues of these organs in hexapods, and, in June, 1876, so informed Dr. A. S. Packard, Jr., to whom I submitted specimens Through his courtesy I have recently (Jan. 5, 1877,) had the pleasure of perusing an elaborate and admirable article by P. Kramer, of Schleusingen, Prussia, on the natural history of certain genera in the family Gamasidæ, published in the *Archiv fuer Naturgeschichte*, 42d year, Part I, 1876. According to Kramer these hitherto undescribed organs (his *Scheerentaster*) occur in most Gamasid mites, though differing greatly in length and considerably in form in different species He considers them 3-jointed. the basal joint simply cylindrical, the second likewise so at base, but ending in a strongly chitinized claw, generally toothed inside, and the third forming the inside finger of the claw, also generally toothed. In *Uropoda Americana* no true joints are discernible in the body of the processes, though there are restrictions. These maxillæ are evidently elastic and the anterior portion may be retracted more or less into the basal. Nor should I designate as a joint the thumb-like articulation of the terminal claw. Indeed, these claws seem to me to both of them articulate on the end of the process. In the species under consideration two teeth are sometimes discerned on the small thumb, but ordinarily they are not easily resolved.

ITS INTRODUCTION TO EUROPE.

While some Europeans have been unduly alarmed, and inclined to take proscriptive measures to prevent the insect's introduction, others have ridiculed the idea that the insect could get to Europe, one of them declaring that there is no more danger of the insect's chance transportation than that of our rattlesnake.

The opinion is also freely expressed by certain good authorities, that the female could not retain her eggs during a whole passage. They forget that the eggs are laid at different times, covering a period of several weeks, and that the hibernating beetles are restless and active, without inclination to lay, for several weeks in Fall and Spring.

The actual occurrence of a living beetle on the Bremen Dock Yards, in a cargo from New York, was extensively reported in the press last Summer, but as the accuracy of the report was subsequently questioned, I took some pains to ascertain the truth. The German Consul at New York, H. A. Schumacher, obtained for me every assurance of the fact; while Prof. Dr. Buchenau, of Bremen, confirms it. The beetle was found alive in unloading a cargo of Indian corn from the steamer "Neckar," and another specimen was found in mid-ocean on the coat of a passenger of the same vessel.

Others, and among them some good entomologists, particularly of the Belgian Entomological Society, continue to express the belief that our Doryphora would not thrive if introduced. I have already expressed my belief that "an insect which has spread from the high table lands of the Rocky Mountains across the Mississippi Valley to the Atlantic, and that flourishes alike in the States of Minnesota, Wisconsin, Upper Canada and Maine, and in Maryland, Virginia and Texas—in fact, wherever the potato succeeds—will not likely be discomfited in the potato-growing districts of Europe."—7th Rep., p. 5.

The more serious and weighty reasons against the possibility of acclimatization, have been urged by H. W. Bates, F. L. S., in a memoir published in 1875, in the Journal of the Royal Agricultural Society of England, (Vol. XI, Part II). He argues, firstly, that no American beetle has been acclimated in Europe, though several European species are known to have been in America; secondly, that the group to which Doryphora belongs is not represented in Europe, and is remarkably restricted to elevated plateaux in the interior of this continent, and range toward the tropics rather than toward the north; thirdly, that the insect has not passed west of the dividing ridge of the Rocky Mountains, or got foothold on the Pacific Coast, which in climate more nearly resembles Western Europe.

Mr. Bates lays some stress on the fact that few American plants and insects have been acclimated in Europe, citing only the Common Water Weed, (*Anacharis Canadensis*), which has spread through their ponds and canals, and the Grape Phylloxera, which has done so much injury to French vineyards. He also says that no American beetle has become acclimated. While it is true that we have received many more species than we have given, enough more of our insects and plants have established themselves there to weaken the force ot the objection. The Horse Weed, (*Erigeron Canadense*), and the Grape Mildew, (*Oidium Tuckeri*), may be added to the plants; our common White Ant, (*Termes flavipes*), has done much damage in some parts of Germany; the Woolly Aphis, or American Blight, (*Eriosoma pyri*), is quite a pest in England and on the Continent; a minute yellow ant, (*Myrmica molesta*), which so annoys our housekeepers, has, according to Fr. Smith, been naturalized, and is very troublesome in England; while at least two of our beetles, viz., the Pea Weevil, (*Bruchus pisi*), and the American Meal Worm, (*Tenebrio obscurus*), have been naturalized in Europe—the former doing some damage in S. France; the latter being quite widespread and now sent back in about equal numbers with the European Meal Worm, (*Tenebrio molitor*), by those who make a business of rearing the worms for bird fanciers.

There is some force in all of his arguments, but Mr. Bates does not sufficiently appreciate the exceptional adaptive and migrating powers which the species has exhibited. There are hundreds of North American insects—and some of the most injurious too—which no one fears will ever reach Europe or establish themselves there, because they are restricted, and have for years been restricted to certain geographical areas. They have exhibited no especial powers of adaptation to new conditions. But our Potato-beetle forms one of those exceptional cases that occasionally confront us. We mark and note the exceptional vitality though we cannot give a reason for it. Why has *Doryphora* 10-*lineata* overrun the country and become such a pest, while its scarcely distinguishable congener, *Doryphora juncta*, feeding on the same genus of plants, has proved incapable of that adaptation, and remained harmless? Whatever the reason, the fact weakens the force of all generalizations based on geographical distribution. The reasons why the species has not passed west of the Rocky Mountains, find also their best explanation in the facts already mentioned in considering the causes which limit its spread.

The possibility of its importation, in a living condition, on vessels, is now assured by the experience of the year 1876, and I

must think, with the facts before me, that the possibility of its acclimatization is equally great, especially in South Europe. That it would also hold its own in England and Ireland I have not much doubt. It will rather enjoy the more temperate climate; for while it thrives best during comparatively dry seasons, both excessive heat and drouth, as well as excessive wet, are prejudicial to it. Let us hope that it never will become established in Europe, but that a sufficient knowledge of it will be disseminated there to cause the speedy detection and extermination of the few that may, from time to time, be carried over. Let the Europeans not neglect precautionary watchfulness, however, by virtue of the arguments of those who believe that the insect could not stand their climate—lest they some day learn to their sorrow that they have needlessly underrated our Doryphora's toughness of constitution.

It is gratifying to note that some of the governments are not neglecting those precautions. The Commissioners of Customs in Great Britain have issued an order, accompanied by a description and figure of the insect, directing the officers of the Out-Door Department of the Service to especially look for and destroy any beetle answering the description given, which they may find "on board vessels, or on wharves, quays, sheds, or packages landed from vessels," and to encourage other persons to do the same.

The German Government has also issued a fine colored placard, to be posted on ships communicating between the two countries. Surrounding well executed figures of the insect in different stages, occur the following appeal and directions, the whole gotten up very much as recommended in my 6th Report.

LOOK OUT FOR THE POTATO-BEETLE!

A warning and request, addressed to all who can assist in preventing the importation of this beetle, and thereby make themselves Benefactors of their Fatherland.

Published by Order of the Royal Prussian Agricultural Department.

The drawing herewith presented shows the insect, with eggs and larvæ, which is known in North America as the Potato-beetle, Colorado Potato-beetle, Colorado bug and Potato-bug; and which, of late years, has damaged the potato to such an extent as to render its cultivation, in some parts of America, almost impossible. Therefore the importation of this beetle into Germany should be prevented by all possible means. The Potato-beetle and its larvæ live principally on the leaves of the potato plant; but it has also been known to feed on the different species of night-shade, on the tomato, and even on cabbages.

[Here follows a succinct and very good account of its natural history, and of its spread over the continent]

The only danger of importation of these insects into Germany lies in the maritime intercourse between the two countries. Swarms of the beetles are carried out to sea by the wind, and it is not improbable that numbers of them might fall onto ships, and so reach, alive, the German sea-ports, it being proved by experiment that they can exist for six weeks without food whatever. It is also possible that they might be brought on ship-board singly through being packed in with vegetables purchased in American sea-ports, such as cabbages or tomatoes, or other merchandise. Larvæ and eggs might be shipped in like manner. [This, as I have already shown, is unlikely.] In

the earth adhering to the potatoes there is also danger, as with it the pupæ and even the beetles can be imported.

Now, as all remedies hitherto tried against this pest, such as hand-picking or poisoning in the fields, have proved unsatisfactory [it is scarcely necessary to state to the American reader that this is incorrect], the importation of the beetle into this country would be simply the destruction of German potato culture, on which, in a great measure, depends the subsistence of our population.

All captains, crews and passengers on vessels running between America and Germany will, we hope, willingly lend their assistance to the prevention of such a calamity by keeping a sharp look-out for beetles, eggs, larvæ and pupæ; by destroying every specimen found on ship-board; by avoiding all unnecessary trade in vegetables; by using all possible precaution in the matter of clearing ships, etc.—thus materially helping the officers of our sea-ports.

All officers of German sea-ports are requested to inspect keenly all articles of American export whereby the beetle might be unintentionally introduced into Germany. The importation of potatoes from America, and the transferring of potato peelings and kitchen waste from the ships to land, is herewith forbidden.

"POTATO PEST POISON."

Several persons wrote last Summer to get my opinion of a purported new remedy for the Colorado Potato-beetle, then being extensively advertised under the above name by the Kearney Chemical Works, 66 Cortland street, New York City. I should, on general principles, dissuade any one from purchasing a secret remedy, when a cheap, simple and effective one is well known. Yet, as there is always room for improvement, and the inventor and discoverer of something valuable has a right to profit by his discovery if he can, I am just as ready to commend as to condemn any insect remedy offered to the public, according as it merits condemnation or approval—desiring to do justice to the rights of the individual as well as of the public. What, then, is this *new* "Pest Poison," and does it represent some valuable discovery which deserves to be kept a trade secret? Or is it simply one of the many secret nostrums constantly offered to the farmer by schemers who desire to fill their own pockets? Let a candid consideration of the matter decide.

The circular of the firm claims that this "pest poison" is manufactured on "strictly scientific principles," and that it is "the only safe, sure and cheap destroyer of potato and tomato bugs, chinch bugs, cut worms, wire worms and army worms, caterpillars, and all insects which prey upon vegetation!" Whenever men are found making the ridiculous claim, for any substance whatever, that it is a universal cure for all noxious insects, it is safe to set them down as ignoramuses or charlatans. The habits and modes of life of insects are so varied that what may prove a perfectly satisfactory remedy against one species is often utterly worthless against another; while for successful warfare special tactics are required in almost every case. The circular further unqualifiedly claims on one page that the poison "is not injurious to vegetation," while admitting in a special notice on another page "that, if used too strong or too frequently, it injures

vegetation." The truth is that many tender plants are injured by it even when used as recommended, while even stout leaved evergreens are seriously injured when the strength of the solution is doubled. In the "directions for use" we find brief accounts of various insects, which show on their face that the authors of the circular and agents for the poison know nothing about the insects they speak of, and recommend their poison for species upon which it has never been tried. The directions under the head "Army Worm" may be taken as a sample. The passage, with the exception of the first and last sentences, is taken almost word for word, without credit, from an article of mine (New York *Tribune*, November 16, 1875); and in the sentences excepted, we are told that the army worm belongs to the "order of *noctua!*" (*Noctua* is an old genus of the order *Lepidoptera*), and that for this insect the solution must be made of double strength, whereas, thus made, it will injure most grasses.

The special notice closes with the following paragraph:

> Furthermore, lest a prejudice should be founded on the fears of some people that the vines or crops will absorb the poison, we have before us detailed experiments for several years past showing that not a trace of this poison has ever been found in potatoes or grain which have been watered with this solution in much greater quantities than was necessary to destroy worms or insects, and the opinion, also, of eminent chemists, that once in the ground the poison is completely neutralized.

Here again the circular misleads, and I very much doubt whether there is a particle of truth in the statement as to the years of experience or the opinions of eminent chemists. Such language would hold true of the Paris green mixture, but not of the poison advertised. This, upon analysis, proves to be a mixture of arsenate of sodium and common salt, faintly colored with rosaniline; and as opposed to the opinions of the unnamed "eminent chemists" of the circular, I will quote the opinion of Professor Wm. K. Kedzie, of the Kansas State Agricultural College, who says that "the great objection to the use of these compounds is their extreme solubility in water. They are offered to the plant in perfect condition for absorption into its circulation; and while, in the case of Paris green, the minute proportion dissolved is at once rendered inert by the hydrated oxide of iron in the soil, it is by no means certain that the proportion of the latter is in every case sufficient to accomplish this when the arsenic compound is applied in such large quantity and in complete solution."

Last year, in my eighth Report, I had something to say of a "Potato Pest Poison," manufactured by the Lodi Chemical Works of Lodi, N. J., showing that it did not work as effectually as the Paris green mixture, and that there could be no advantage to the farmer in its employment. It was composed of equal parts of salt and arsenic (arseniate of soda). Experiments which I made last Summer show

that the Kearney pest poison acts very much like its Lodi prototype, the only advantage over which it can claim being the faint coloring. The Lodi Company sold a 1 lb. package for $1, which was to be dissolved in 120 gallons of water or more. The Kearney Company sell a half pound package for 50 cents, which is to be dissolved in 60 gallons. Of course either company could get any number of testimonials as to the efficiency of their compounds. They herewith have mine. To put forth the false claim of the circular I have noticed, is simple humbug. There are plenty of farmers, who, rather than go to the trouble of making their own mixtures, will send for such poison packages, when they once know what the mixture is, where they would not think of ordering a secret remedy. My advice to the manufacturers would be "do not sail under false colors, or claim more than your mixture deserves: let people know that there is just as much danger, if not more, in its use, as there is in the use of Paris green in the wet method. Do this, and put your article up in more secure packages, so that the poison in deliquescing does not soak and drip through in hot weather as it now does; and I believe you will still do a good business, and deserve *not* to be ranked as charlatans."

THE ARMY WORM—*Leucania unipuncta* Haw.

FURTHER NOTES AND EXPERIMENTS THEREON.

In the article on this insect in my last Report, certain important and mooted questions as to the mode, place and time of oviposition were settled definitely by observation. I have made further observations and experiments during the past year which are of interest as completing our knowledge of this insect's natural history. They were summed up in a brief paper read before the American Association for the Advancement of Science at its meeting in Buffalo, and what follows is mainly taken therefrom.

The eggs are thrust in between the sheath and stalk of well grown grasses, whether cut or standing; or occasionally in between the natural fold of the green leaf or the unnatural curl at the sides of a withered leaf. On low blue grass, where my first observations were made, they are, as stated last year, almost invariably laid in the fold at the base and junction of the terminal leaf with the stalk. The

moth invariably endeavors to secrete them. They are generally laid in single rows of from five to twenty and upward, and they are accompanied with a white, glistening, viscid fluid, which glues them to each other and to the plant, and, when laid in the fold of a spear, draws the two sides securely over them, leaving but a glistening streak along the more or less perfectly closed edges.

There is one other mooted question in the natural history of the Army Worm which I have, the past Summer, been able to settle, viz. whether the species is single or double-brooded. In the review of the matter in my 8th Report, I came to the conclusion that, in the more northern States at least, or over the larger portion of the country in which it proves injurious, it is but single-brooded; and I am still of the opinion that such is the case. But I have proved that, like so many other species which are single-brooded further north, it is frequently, if not always, double-brooded in the latitude of St. Louis. By carefully feeding the moths reared from my first larvæ with sweetened water, and supplying them with grass in spacious vivaria, I succeeded in obtaining eggs from them. These eggs in due time hatched, and the second brood of worms gave me the moths again early in August. The worms were generally paler than those of the first brood, and being the second generation reared in confinement, they were less healthy. I obtained, in consequence, but five moths, all of them unfortunately females. One of these escaped, three died without showing any development of the ovaries, while the fifth died with the ovaries so well developed that the eggs, in a state of nature, would probably have been laid within a week. This was about two weeks after issuing or about the middle of August, and would indicate that a third generation of worms may exceptionally be produced. Indeed, by dilligent search out-doors I found larvæ of different sizes all through the month of August, and a few full grown individuals as late as the 23d of September. Moths were also obtained as late as October 9th from such worms. There is the greatest irregularity about the development of individuals of the same brood and little doubt in my own mind that while the production of a third generation of worms is the exception it may some years prove the rule.

The male moths, reared and fed in confinement, lived on an average 10 days; the females which were impregnated, twice as long, commencing to lay about a fortnight after issuing. What I have previously said as to the longevity of these moths applies therefore to the last or Fall brood only. The worms obtained the latter part of September entered the ground and were found dead upon subsequent examination, but would doubtless have hibernated in chrysalis and confirmed

the conclusions which I have drawn (Rep. 8, p. 45) that the species may hibernate in the chrysalis as well as the moth state.

All the observations I have made are in harmony with the practical conclusion arrived at a year ago, that the eggs of this insect do not, as a rule, if at all, pass the Winter at the foot of grass stalks, as was heretofore surmised. Nevertheless, the burning over of meadows and grain stubble in Winter will act as a preventive of Army Worm injuries, for the reasons that the moth lays very early in Spring, that she prefers the full-grown sheath and stalk, even when dry, to the young green spears, and that she cannot well lay her eggs, for want of support, where the grass is yet sparse and thin, as it is when first starting in a burned meadow. In my last Summer's experiments the females, in secreting their eggs, invariably showed a preference for old hay over fresh and growing grass. Finally, without entering into further details, I give the following as a revised summary of the history of the Army Worm:

SUMMARY OF ITS NATURAL HISTORY.

The insect is with us every year. In ordinary seasons, when it is not excessively numerous, it is seldom noticed: 1st, because the moths are low, swift flyers, and nocturnal in habit; 2nd, because the worms, when young, have protective coloring, and, when mature, hide during the day at the base of meadows. In years of great abundance the worms are generally unnoticed during early life, and attract attention only when, from crowding too much on each other, or from having exhausted the food supply in the fields in which they hatched, they are forced, from necessity, to migrate to fresh pastures in great bodies. The earliest attain full growth and commence to travel in armies, to devastate our fields, and to attract attention, about the time that winter wheat is in the milk—this period being two months later in Maine than in Southern Missouri; and they soon afterwards descend into the ground, and thus suddenly disappear, to issue again two or three weeks later as moths. In the latitude of St. Louis the bulk of these moths lay eggs, from which are produced a second generation of worms, which become moths again late in July or early in August. Exceptionally a third generation of worms may be produced from these. Further north there is but one generation annually. The moths hibernate, and oviposit soon after vegetation starts in Spring. The chrysalides may also hibernate, and probably do so to a large extent in the more northern States. The eggs are inserted between the sheath and stalk, or secreted in the folds of a blade; and mature and perennial grasses are preferred for this purpose. The worms

abound in wet springs preceded by one or more very dry years. They are preyed upon by numerous enemies, which so effectually check their increase, whenever they unusually abound, that the second brood, when it occurs, is seldom noticed; and two great Army Worm years have never followed each other, and are not likely to do so. They may be prevented from invading a field by judicious ditching; and the burning over of a field, in Winter or early Spring, effectually prevents their hatching in such field.

THE WHEAT-HEAD ARMY WORM.—*Leucania albilinea** Guen.

There can be no more tangible evidence, in present time, of the truth of evolution, and of the constant modification in habit, and consectaneous modification in structural and colorational characteristics among animals, especially among the lower classes, than the frequent appearance, as destroyers of our crops, of insects that were never reported as injurious before. When entomologists speak of a new insect enemy, they are not to be understood as implying a new creation. In a great majority of instances the species has long before been known to them, and has simply, for one reason and another, become unduly multiplied so as to force itself upon the attention of the common observer. In other cases it is new only to a particular locality to which, from some other region, it has been introduced. Yet in the most restricted and well worked-up localities, speaking either zoölogically or botanically, new forms appear, and old forms sometimes disappear, in a manner which can scarcely be explained, except by the extinction of the one and birth of the other through modification. Few naturalists at this day doubt that new forms have thus originated in the past.

[Fig. 14.]

WHEAT-HEAD ARMY WORM:—*a*, *a*, larvæ; *b* eggs—nat. size; *c*, *d*, egg, top and side view—enlarged.

*As will be shown at the close of this article, this insect is quite variable and has received another name. I employ the above name simply because it is appropriate and because the insect fully agrees with Guenée's published description. To say *albilinea* Huebn, carries no such definite idea, and *Harveyi* Grote is, in my opinion, but a variety. There is and always must be doubt as to what *albilinea* Huebn. virtually is, since it is founded mainly on a figure; and where there is such indecision it is, in my judgment, and in that of many others, best to discard Hubner. It is for this reason that I consider Guenée's description original, as applying to the species under consideration, and that his name should not be superceded by any other under which the insect may have been subsequently defined.

They are thus originating at the present, and we may occasionally get a glance at the process by the phenomena just referred to.

In the Summer of 1874, reports were not unfrequent of injury to wheat and timothy heads in Maryland and Pennsylvania by a worm which, by rearing, proved to be *Leucania albilinea* Guen.

In June and July of 1875, complaints were again heard, particularly in the two States mentioned, of a worm that injures the heads of the small grains while in the milk. The *Baltimore American* (see *Weekly N. Y. Tribune*, July 13, 1875,) describes it as hollowing out the soft grains, and leaving nothing but the shell and the chaff, and says that "in some rye fields the heads are almost void of grains, and the ground literally covered with chaff," and that "late sowed rye would not be worth the harvesting were it not for the straw." A correspondent from York, Penn., (July 15, 1875,) describes it as playing sad havoc with the wheat-heads here. Wm. T. Smedley, of Lionville, Chester county, and S. S. Rathvon, of Lancaster, Lancaster county, Penn., sent me specimens in 1875, with accounts of their attacking timothy seed and wheat while yet soft. The complaints were more numerous in 1875 than in 1874, though still confined to the Eastern States.

In 1876 this worm suddenly made its appearance in Kansas, especially in Dickinson, Douglas and Davies counties. The first specimens I received were accompanied by the following letter from Mr. Jno. W. Robson, of Cheever, Dickinson county, and dated June 14, 1876:

> I inclose a number of caterpillars which are devastating the wheat fields of this county and causing considerable alarm. It was first noticed about ten days ago on Holland Creek, south of the Smoky Hill River, and along the east line of the county north of the same river. Yesterday I discovered it in our wheat. I live close to the north line of the county. This insect is quite new to me, but I judge it belongs to the order Lepidoptera, and strange to say, though a pretty close observer of insect life, I have not noticed any unusual quantity of moths or butterflies hovering over the wheat. The caterpillars begin their depredations at the base of the ear, and sometimes near the center of the ear. In one field that I examined to-day, the caterpillars were abundant. They were mostly at rest, reclining at full length upon the straw, while only a few were feeding on the ears. Any information will be thankfully received. Farmers calculate that they will lose one-third of their crop.

In addition to the specimens received from Mr. Robson, others were sent to me about the same time from different parts of Dickinson, Douglas and Davies counties in that State. The *Salina* (Kansas) *Herald* refers to the ravages of this same worm in that neighborhood, and the *Kansas Farmer* of June 28, publishes several items which indicate that the pest has created no little excitement. As grain began to ripen in the East, the worm again attracted attention there, and specimens were received from Mr. G. W. Shaw, with an account of their ravages along the old Reading Railroad, in the immediate

vicinity of Philadelphia. The insect is also alluded to in the *Country Gentleman* for July 15, as doing injury in York Co., Penn.

Now the interesting feature about this insect is that its appearance in such destructive numbers and its habit of attacking wheat heads are modern phenomena. None of the early writers on economic entomology in this country refer to anything of the kind, and the first notice that I recollect seeing of this habit in this insect was in the Summer of 1872, when, in the *Tribune*, Mr. R. W. Hudson of Huntington county, Penn., described a worm which seriously injured his and a neighbor's oats fields by destroying the heads, and which was erroneously supposed to be the Army Worm. It is highly improbable that the conspicuous ravages of a worm of this kind could have gone unnoticed and unrecorded, either by farmers or entomologists, if they had occurred; and the fact that the species shows a large degree of variation, warrants the belief that it has been lately modified. Feeding originally on some wild grass; undergoing modification, and first acquiring the peculiar habit here described in York county, Pennsylvania, this wheat-head-feeding race may subsequently have been carried to Kansas either in the chrysalis or moth state, or, what is more likely, in the egg state on grain and grass. This would account for its attracting attention there before it was noticed in the intermediate country. Yet a dark form occurs in the immediate country, because I reared such a dark form, answering to Hübner's figure, in 1870, from larvæ that had transformed in a rye field at Kirkwood, Missouri. The wheat-feeding race may be expected to widen the area of its devastation until it spreads over the larger part of the country, and, like its long and well known congener, the true Army Worm, becomes unusually abundant and injurious, whenever the conditions are favorable to its multiplication. We may also expect an increasing tendency in the species to vary, and give rise to still other varieties and races that will perplex definers and describers.

HABITS AND NATURAL HISTORY.]

As I have abundantly proved, by rearing one generation from the other, this insect is double-brooded with us.* The first moths appear

[Fig. 15.]

MOTH OF WHEAT-HEAD ARMY WORM.

* It is quite probable, however, that, as with the true Army Worm—which, as we have just seen, is double-brooded with us though evidently single-brooded further north—this, its congener, produces but one brood annually in higher latitudes, the insect hibernating mostly in the perfect state. Indeed, there would seem to be such irregularity in this regard that both peculiarities may occur in the same locality; for of a number of chrysalides collected at Lionville, Pa., in August, by Mr. Smedley, from among the shatterings that fell from the mow when threshing wheat that had been harvested early in July, a few only gave out the moths, and the rest are hibernating. Moreover, it would seem that where one brood only is produced, the moths partake of the intermediate characters between the summer brood, which has the pale secondaries and accords so fully with Guenée's description, and the spring brood with darker secondaries, which accords with Grote's *Harveyi;* for specimens bred by Mr. Lintner, of Albany, New York, in August, have, in both sexes, the intermediate size and the secondaries quite distinctly dusky around exterior border but not basally.

during May, in the latitude of St. Louis, and the bulk of their larvæ are full-grown about the time wheat is in the milk. These produce moths again during the latter part of July, and, in their turn, these lay eggs which produce a second brood of worms in August. These become chrysalides toward or during September, and hibernate as such in the ground.

The habits of the worm, when full grown, are well set forth in what has been already said, and the peculiarity of feeding upon heads of the small grains is quite marked. It prefers the grain itself to all other parts of the plant, and generally leaves the glumes, or gnaws and lets them drop so as to cover the ground with chaff.

The horny outer parts of the ovipositor of the female have very much the same form, appearance and structure as in the true Army Worm (Rep. 8, Fig. 19), the compressed blade being somewhat less robust and less produced and rounded at the upper end. The eggs are also secreted as in that species, and as one might naturally expect from the unity of habit that generally prevails in the same genus. These eggs are, in fact, thrust, in single, double or treble rows of five to fifty or more in a row, between the sheath and stalk of the grains upon which the worms are destined to feed. They are generally fastened, but very slightly, to the inside of the sheath, and are readily seen upon pulling this aside (Fig. 14, *b*). They are thrust in sidewise, compactly pressed together, and not covered with any glistening or adhesive fluid as in *unipuncta*. Each egg, when examined closely, is found to be very soft and yielding, so that its form is fashioned somewhat by the pressure it receives from its neighbors and from the leaf. Normally, the form is of a compressed sphere, the depth from top to base being about half the transverse diameter. The shell is corrugate rather than granulate, the corrugations assuming upwards of thirty more or less distinct ribs. Pale yellowish and translucent when first laid, it becomes slate-colored before hatching, and the shell is so extremely delicate that every hair of the embryon may be seen through it, and it collapses and is scarcely visible after the young worm has hatched. In its rougher and ribbed surface, compressed form and other characteristics, it differs sufficiently from the egg of *unipuncta* to show that egg structure alone cannot be relied on as of much value in generic diagnoses. The eggs hatch, in Summer temperature, in from three to five days from date of deposition.

The newly hatched larva, as in *unipuncta*, is quite a looper, the prolegs on joints six and seven being still more atrophied, and those on joint eight being short. The body is pale at first, with a black head and shiny spot on top of first and last joints. It soon becomes

green, with a brown head; then striped, with five pale and six darker lines, and after going through five and sometimes six molts, the worm assumes the appearance of Fig. 14, *a*, *a*. When full grown, the best marked specimens are prettily striped with sulphur-yellow and straw-yellow, and with light and dark brown, as follows: A broad, dark brown line along the back, divided along the middle by a fine white line generally obsolete behind; beneath this broad line, on each side, a straw-yellow line, half as wide; then a light brown one of the same width as the last, and becoming yellow on the lower edge; then a narrower dark brown one, containing the white spiracles; then a sulphur-yellow as wide as the third; then a less distinct light brown subventral one, the venter being pale yellow. The head is large, straw-colored, and with two attenuating brown marks from the top to the lower face.

This worm when newly hatched is, therefore, at once distinguished from *unipuncta* or the true Army Worm, by its black head; later by having superiorly five instead of seven pale lines, and six instead of eight dark ones, and when full grown, by its brighter, more strongly contrasting colors, and paler head.

The habit of feeding on the grain becomes pronounced only after the worms are half grown, and prior to that time they feed on the leaves, and are seldom noticed.

The chrysalis is naturally formed just beneath the surface of the ground, but frequently under weeds and other rubbish. It is of the ordinary mahogany-brown color, terminates in a stout horny point, with a corrugated base, and is at once distinguished from *unipuncta* by the stigmata being raised on a rounded prominence, and by other particulars mentioned in the description at close.

The worms acquire their full growth in from three to four weeks from hatching, those of the second brood developing somewhat more slowly than those of the first. The chrysalis state in the Summer brood lasts from ten to fifteen days. The parent moth (Fig. 15) has the front wings pale, straw-colored, with a white line running along the middle to the outer third, and shaded with brown and purplish-brown as follows: A shade beneath the white line, intensified at each end where it joins the white; another along the posterior border, narrow at apex and broadening to the middle, where it projects along the middle of the wing above the white line, fading away toward base, and a fainter shade along the front or costal edge, intensifying toward apex.

NATURAL ENEMIES.

The worm is subject to the attacks of three distinct parasites. One, the very same species of Tachina-fly (*T. anonyma*) which I have

so often bred from other insects; the other a pretty Ichneumon-fly (*Anomalon apicale* Cresson) which may be called the Dark-tipped Anomalon.

Of a lot of over a hundred chrysalides received from Mr. John Davis, Junction City, Kansas, fully forty per cent. were destroyed by this parasite, which undergoes its transformations within the chrysalis shell, spinning but a very thin layer of silk on the inside thereof, and issuing finally by gnawing and pushing off the anterior portion.

It is rather a pretty species, about 0.90 inch long, exclusive of antennæ. The wings are smoky-brown, with deeper brown veins, a golden reflection toward base, and a clearer space at tip of front ones. The face and cheeks are pale yellow, with the top of head and eyes black. The thorax is marked with yellowish-brown and black and the compressed abdomen is reddish-brown, with the truncated end more or less black. The legs are generally pale, with the exception of the thighs and tips of shanks, which are darker.

The third parasite is a genuine Ichneumon (*Ichneumon brevipennis*) originally described by Mr. Cresson from Colorado. It may be popularly called the Short-winged Ichneumon and is characterized by its pale reddish-brown color and short, smoky wings.*

REMEDIES.

It is quite evident from the foregoing history of this destructive worm that the practical means of counteracting its injuries are chiefly preventive. It cannot be successfully fought in the worm state, and the wheat grower who has been troubled with it should direct his attention to the destruction of the chrysalides by late plowing and harrowing and to the capture of the moths in Spring by means of lights and sweetened and poisoned fluids. We can hardly hope that such preventive measures will be very generally adopted, especially as at best they would prove but partially successful; and I confess that the species, from the character of its food and of its life-habits must be, with our present knowledge, placed in the category of insects whose management baffles man, and must be left to the work of their natural enemies.

DESCRIPTIVE.

Leucania albilinea—*Egg*—0.5 m.m. wide, generally but half as deep, the top and base being quite flattened. Color pale-yellowish, translucent and less iridescent than in *unipuncta*: with rugosities which assume on upward of 30 more or less distinct ribs: becoming slate colored before hatching: shell extremely delicate and generally collapsing after exit of larva.

* The specimen, which Mr Cresson has kindly compared with his type, differs therefrom in having the wings relatively longer and in the narrow black bands at basal margin of abdominal joints 2, 3 and 4, being obsolete. It may be distinguished as a variety of *brevipennis* for which I propose the variety name *obsoletus*.

Larva—Newly hatched larva 1.9 m.m. long. Like *unipuncta* quite a looper, the prolegs on joints 6 and 7 very much reduced and useless. Head, cervical shield, and shield, thoracic legs, rings on prolegs, piliferous spots which are conspicuous and normal in position, and bristles from them—black. General color sordid white, soon becoming green. In the *second stage* the black parts become brown, and the body above shows five pale lines on a ground of six dark ones, (in *unipuncta* there are 7 pale and 8 dark ones) generally indicated in the latter part of the first stage. In the *third stage* the head is gamboge-yellow, and the dark lines are olivaceous and the contrast with the five pale lines and the pale venter more decided. The looping habit is also abandoned. In the *fourth stage* the head is honey-yellow with the mature markings indicated in brown, and the five pale superior lines, especially the mediodorsal and the next to it which is broadest, are relieved more strongly by a deepening of the borders of the dark lines. In the *fifth* and *sixth stages* the characters of the mature larva are approached by the narrowing of the medio-dorsal pale line, the deepening of the dorsal and fading of the subdorsal dark space; by the separation of the subdorsal pale line into two, and by the deepening of the stigmatal dark line.

Mature Larva—Average length rather more than an inch. Colors pale yellow and brown. The brighter marked specimens have the dorsum brown with a narrow medio-dorsal yellow line, obsolete posteriorly; then a subdorsal sulphur-yellow line ½ as wide and suffused in middle with carneous; then a still narrower brown line, ill defined, beneath; then a yellow line of same width as preceding; then a somewhat broader brown-black stigmatal line; then a substigmatal sulphur-yellow line as broad as subdorsal and generally relieved below with pale brown—all the dark parts, except the black stigmatal line, speckled with yellowish. Venter dull white. Head large, wider than body, pale yellow—almost white, with brown tipped jaws, mottlings on the cheeks, and two broad brown marks (with a tendency to fade in the middle) on top, narrowing each side of V-shaped sutures. Stigmata white, with black annulus. (In unipuncta they are dark with a pale annulus). Piliferous spots though more conspicuous than in *unipuncta* in first stage, now less so. Varies considerably, some being quite dark and others greatly suffused with rosaceous; but the pale head, dark stigmatal line and bright yellow lines are constant.

Hundreds of specimens examined. Chrysalis—normal form, and dark mahogany brown. Distinguished at once from *unipuncta* by being more strongly punctate; by the anterior border of the three abdominal joints immediately below the wing-sheaths being but slightly ridged, and deeply, profusely and irregularly punctate all round; (in *unipuncta* these joints have, above only, a clearly defined ridge with a single row of larger and regular punctations) by the stigmata being raised on a rounded prominence; and by the anal joint being much broader and more corrugate at base.

Imago—Average expanse 1.50 inch. Front wings either pale straw, or ochre-yellow with a pale or white line along the median vein, broadening to the disc, and sometimes extending more or less along veins 3 and 4; tapering to base and blending more or less with another pale line which extends a short distance beneath it and fades away posteriorly, each sharply relieved below by a brown-black streak, shaded with brown as follows: a broad pale costal border having a cinereous shade, with the veins, especially towards apex, relieved and pale; a terminal shade with similar cinereous hue, and tapering to apex; a broad shade beneath median white line, with frequently a dark, elliptic streak at its lower border toward base; and generally (not always) connecting more or less distinctly with the terminal shade; and lastly, a cuneiform shade connecting with the terminal from vein 4 to apex, from which it curves abruptly and tapers along the upper border of the median white line, which it helps to relieve. A small discal dot. The tapering shade is generally very clearly relieved by dark streaks at its borders. Fringes white, usually with a dark medial line, and always with a pale inner line relieved by a dark terminal line. Beneath white, with a faint dusky tint opposite the cuneiform shade. *Hind wings*, satiny-white, with frequently a faint dusky shade posteriorly in the ♂. *Head* ochraceous-brown with paler

[Fig. 16]


MAP OF
NORTH AMERICA
Illustrating
The Country East of the
ROCKY MOUNTAINS
overrun by the
ROCKY MOUNTAIN LOCUST.
in 1876
By C.V. Riley
EXPLANATION.
Country overrun
Eggs laid sparsely
Eggs laid thickly
Most threatened in 1877.
BRITISH AMERICA
BRITISH COLUMBIA
CANADA
PACIFIC OCEAN
ATLANTIC OCEAN
GULF OF MEXICO
MEXICO
WASHINGTON
OREGON
CALIFORNIA
NEVADA
IDAHO
MONTANA
WYOMING
UTAH
ARIZONA
COLORADO
NEW MEXICO
DAKOTA
NEBRASKA
KANSAS
INDIAN T.
TEXAS
MINNESOTA
IOWA
MISSOURI
ARKANSAS
LOUISIANA
WISCONSIN
ILLINOIS
MICHIGAN
INDIANA
OHIO
KENTUCKY
TENNESSEE
MISSISSIPPI
ALABAMA
GEORGIA
FLORIDA
SOUTH CAROLINA
NORTH CAROLINA
VIRGINIA
W. VA.
MARYLAND
PENN.
NEW YORK
N.J.
CONN.
MASS.
VT.
N.H.
MAINE
Olympia
Washington
Boise City
Virginia City
Ft. Benton
Old Ft. Smith
Salt Lake Cy.
Ogden
Carson City
San Francisco
Sacramento
Los Angeles
Cheyenne
Denver
Santa Fe
Pembina
Ft. Sulley
Yankton
Breckenridge
St. Paul
Dubuque
Omaha
Topeka
Kansas City
St. Louis
Chicago
Little Rock
Dallas
Houston
Galveston

palpi. *Thorax* of the same color, paler behind; the collar pale lilaceous, with a white upper border strongly separated from the dark anterior border of tegulæ; three white streaks, one medial and one on each tegula. Anterior legs dusky in front, otherwise, with body, ochraceous. Antennæ simple; having but the faintest fringe of hairs in the male. Eighty-four bred specimens from wheat-feeding larvæ examined.

The above description applies to typical Western specimens of the Summer brood.

As in every case where I have studied large material, the species proves quite variable. The dark marks may have an olivaceous hue, or they may so predominate as to form the ground-color of primaries, with the white medial line well relieved, but the pale shades above and below it reduced to streaks. The discal spot is either obsolete, single, or double, and somewhat reniform; the orbicular spot is sometimes indicated; the tapering dark shade inclining from apex reaches either to disc only, or extends to base of wing; the brown-black streaks may be sub-obsolete; the apical angle varies in acuteness, and the posterior border in obliqueness; the terminal line may be broken into more or less distinct dots; and finally, there may be a series of distinct dots between the veins along the inside of terminal shade, and streaks between the veins, recalling *phragmatidicola.*

Not one of the Summer brood has the hind wings "smoky, blackish" that characterizes *Harveyi* as described by Grote; but two Spring-bred specimens, below average size, accord with his description very well, even to the narrower primaries and scarcely obliquing posterior border. *Harveyi* (and perhaps also Hübner's figure) may, therefore, be considered the Spring form of *albilinea,* just as I have proved by breeding that *Pieris vernalis* is but the Spring form of *P. protodice.* Indeed the tendency to smaller size and deeper color in broods that hibernate in chrysalis is very general.

THE ROCKY MOUNTAIN LOCUST—*Caloptenus Spretus*, Thomas.

[Ord. Orthoptera; Fam. Acrididæ.]

This scourge has continued to vitally concern our people and the people of the western country east of the Rocky Mountains. After the fearful ravages which it committed in 1874 and 1875, it will be interesting to take note of its doings in 1876.

It will be remembered, that, in opposition to contrary opinion widely circulated, I expressed my belief, a year ago, that in Missouri, Kansas and Nebraska, first, there would not hatch as many locusts in the spring as would naturally hatch in ordinary seasons from indigenous species; second, that, compared with other parts of the country, those States most ravaged by locusts in the spring and early summer of 1875 would enjoy the greater immunity, during the same season of 1876, not only from locust injuries, but from the injuries of most other noxious insects; that, in short, the people of the ravaged section had reason to be hopeful rather than gloomy; that they certainly would not suffer in any general way from locust injuries in the early season; and that the only way in which they could suffer from the migrating pest was by fresh swarms, later in the year, from the far Northwest.—Rep. 8, 155–6.

Like the other opinions as to the future doings of this insect that I have felt warranted in expressing in an unqualified way, this last was fully justified by subsequent events.

From most of the Western States the crop returns were favorable, though the harvest was in many sections impeded, as it was in 1875, by too much wet weather. In no part of the country was the outlook more flattering than in western Missouri, Kansas, Nebraska, Iowa and the country so seriously ravaged by locusts the previous year, and the farmers throughout that section of country had seldom been freer from insect ravages, or more hopeful. The freedom from other noxious insects was everywhere apparent in our own western counties. In parts of the Northwest, as in the East, the conditions were very different from what they were with us, and the crops suffered more or less from excessive drouth. In Colorado, early in the season, there was some alarm, as the insects hatched in many localities, but by no means so generally as in the previous years. By persevering effort the farmers generally got the mastery over them and have made good crops. In Minnesota, again, in some of the southern counties, where eggs were laid, considerable damage was done, though nothing like as much as in 1875. During the second week of July the locusts took wing from that region, and it is interesting to note that they instinctively took a north and northwest course, just as the fledged insects had done a few weeks earlier in the season from Missouri and the adjacent country to the west the year before. Numerous dispatches to St. Paul, Minneapolis, and other papers, show conclusively that the general direction taken was northwest, and that when the wind was unfavorable the insects awaited a change.

Such was the condition of things up to the early part of August, and I began to hope that the country that had suffered so much of late years by locust devastations, was at last free from the scourge, and would not be overrun again for some years to come. But the great drouth which prevailed in the Northwest appears to have favored the multiplication of the insects in, and their migration from their native haunts, and no sooner had the people begun to congratulate themselves on the good riddance of the pests, than reports came of the movement of new swarms from the north and northwest. From that time on, till the approach of Winter, their movements were reported and they overswept a large part of the Western country.

On the assumption that the hosts that went to make up the invasions of 1873 and 1874 had made an exodus from their native breeding places, and that those, if any, which returned thereto in 1875 were more or less diseased, it was natural to conclude that a few years would be required for the species to again become unduly multiplied there and be constrained to migrate. The intervals that had elapsed in the past between general invasions favored such reasoning. The

fact that the insects had hatched out in immense numbers, in 1875, as high up as British America, from 1874 swarms that had come from the still further north and west,* was then not known to me; and the experience of 1876 proves how little we know of the native breeding haunts of the species, and that the past history of invasions is no certain guide as to the future.

THE INVASION OF 1876.

In order to give a correct idea of the invasion of 1876, I will consider it by States and Territories, and, as far as possible, in chronological order.

BRITISH AMERICA.—In Manitoba, as I learn from Prof. Dawson, the insects did not appear in sufficient numbers to attract attention or do any harm to crops, which were very good, nor were any eggs laid there. Far west of Manitoba, however, he has reason to believe that the insect was produced from the egg over a pretty extensive area north of the 49th parallel, and that such was really the case is substantiated by Mr. Chauncy Barbour of the *Weekly Missoulian*, Missoula, M. T., who wrote me July 21st, that travelers in Spring from Ft. McLeod, British America, some 300 or 400 miles northeast of Missoula, reported vast numbers of the young insects there.

MONTANA.—The insects hatched extensively in this Territory and no doubt went to largely make up the swarms that subsequently reached over the country to the southeast. The Monthly Report of the Department of Agriculture for May and June mentions them (in its usual inexact way, without dates) as occurring in millions and damaging Spring crops, especially wheat, in Deer Lodge, Lewis, Clarke and Jefferson counties; and the following item is quoted by Prof. Whitman from the *Bismark Tribune* of June 14, 1876:

IN THE FIELD, NEAR ROSEBUD BUTTES, May 29, 1876.

"As we move westward the grazing improves, and here in the Little Missouri Valley the season is at least a month in advance of the season on the Missouri. This would be a splendid grazing region, were the water good. The grass is heavy and nutritious, but the water is strongly impregnated with alkali. Millions of locusts are just now making their appearance in this region. Too young to fly or do much harm, in a few days, should the winds favor them, they will sweep down upon the defenceless agriculturalists on the border, doing untold damage."

The Signal Service reported them as being numerous all over the Territory in June, as flying over Virginia City, southwest, during the middle, southeast during the end of July, southeast in myriads from the 1st to the 5th of August, and as continuing to pass throughout the month until the 29th, when their numbers decreased. No eggs reported.

WYOMING.—Reports from Cheyenne show that the insects were abundant throughout the month of August, passing to the southwest, and that swarms were also passing south and southeast on a number of days in September.

DAKOTA TERRITORY.—As already indicated, the insects that had hatched in Minnesota, departed during the fore part of July, mostly in a northwest direction. During that time the winds were for the most part strong from the southeast, and the locusts were carried over Southeast Dakota, and were noticed to be particularly thick at Vermillion. From the 10th of the month the wind was mostly from the northwest,

* See the facts mentioned in discussing the source of the swarms of 1876, further on.

and the insects poured from that direction into the same country that they had previously left. These swarms were doubtless made up of the very insects that had shortly before left Minnesota, reinforced by others that had lived in the Territory; for they were flying at Pembina, mostly south and southeast from the 8th to the 20th of July.

At the Omaha Conference Gov. Pennington stated that the young never hatched in Dakota, founding his statement on the fact, doubtless, that individually he had never seen them around Yankton. I stated at the time that the reports from Signal Service eporters proved the statement incorrect, and the reports for 1876 from various parts of the eastern and southern portions of the Territory show that the young hatched out there early in the season, as they did in parts of Minnesota.* The Signal Service reports them even far to the north at Pembina, as appearing in June.

From the reports, it is evident that after the first week in July the swarms took a south and southeast direction; further, that until toward the beginning of August they were scattering, did but little damage and laid no eggs—thus indicating that they came from but a short distance. By the first of August, however, and from that on, the swarms were more and more dense, extensive and disastrous, indicating that they had come from a greater distance. It was reported from Yankton, August 2, that the Indians would lose half their crops, but the reports generally during the early part of the month were very contradictory, while those received during the latter part of August showed that the locusts were doing but little damage, and that there had been much exaggeration, especially as to the injury in the Red River Valley. The elevators and warehouses in Yankton were doing a large local business in the Fall. Gov. Pennington represents the damage to wheat at only 5 per cent., and states that corn was one-fourth to one-half a crop. Eggs were laid in the extreme southwest corner, but principally, I think, by the insects from Minnesota. Considerable injury seems to have been done to fruit trees, which in many localities were stripped. Such trees put out fresh leaves and even bloomed again, and it was noted that a frost in September, which stripped most trees of leaves, left the new growth on the locust-stripped trees untouched. I have observed similar results elsewhere.

MINNESOTA—Less fortunate than the States to the South, a good supply of eggs was left in the ground in 1875 in some of the more sparsely settled counties to the Southwest, including Murray, Cottonwood, Watonwan, Brown, and parts of the adjoining counties. Many of the farmers were unable to get large amounts of seed-wheat, after three years depletion. The average sown to small grain was, therefore, small. Yet, from statistics furnished me by J. B. Phillips, Commissioner of Statistics, the estimated yield of wheat in the State, notwithstanding all drawbacks, was over 15,000,000 bushels. After the grain was up and the locusts had began to hatch, it was considered in many cases to be more profitable to seek the certainty of employment elsewhere, than to take the chances of (at best) a small crop at home. But there were quite a number of cases in which men, by using various means, succeeded in saving half or two-thirds of a crop; and reviewing the situation in Blue Earth county, the Mankato *Review* of August 15, says:

> It is a notable fact, worthy of mention, in this connection, that the grasshoppers were very bad in the town of Rapidan, but under the vigorous fight instigated by the county and local bonus, the loss was comparatively light—only 6,570 bushels, and the average yield of the town, not including this loss, was about 16 bushels to the acre. The town of Lyra was much less affected by grasshoppers, yet its loss is nearly 2,500 bushels in excess of Rapidan, a sum more than sufficient to pay the local bounty of the latter town.

* See, more particularly, the records published by Mr. Whitman in his "Report on the Rocky Mountain Locust for 1876."

During the second week of July, these home-bred locusts took wing, and it is interesting to note that they instinctively went in a north and northwest course, just as the fledged insects had done a few weeks earlier in the season, the previous year, from Missouri, and the adjacent country to the west. Numerous dispatches to St. Paul, Minneapolis and other papers, show conclusively that the general direction taken was northwest, and that when the wind was unfavorable, the locusts awaited a change.

The exodus to the northwest was, however, by no means so general as from the more southern country the year before, and, as I learn through Mr. Whitman, many of the insects remained and commenced laying early in July, within two weeks after they had commenced to fly, and not many miles from their hatching grounds. This has never occurred in our own State, and simply indicates what I have in these Reports maintained, viz: that Minnesota is so much nearer the native home of the insect that the species can sustain itself for a longer time there.

The swarms that left early in July returned, did more or less damage, and toward the end of the month left in numbers in a southerly direction. Some, however, remained. About the 6th of August fresh swarms came from Dakota, having been heard of on the 23d of July as passing over Gen. Crook's army. These, as I learn from Mr. John C. Wise of *The Weekly Review*, Mankato, by letter of August 22, pushed continuously to the southeast, and reached as far east as they were ever known to do, or as far as the southwest corner of Dodge county.

The Pioneer Press and Tribune of the 19th remarked:

They appear to have left the southwestern counties and moving northward, have settled down on strips of land, to a width of 65 miles, extending from the upper part of Nicollet county to Minnesota Falls; south to a line drawn between these points there are but few hoppers reported, and they are not doing any damage—but they extend northward up to Otter Tail county and beyond.

They were found at intervals over that whole country, depositing eggs, doing much damage in some localities and scarcely any to others. They came too late to do much damage to the principle crops, which were mostly harvested. If we study the reports from the south and southwestern parts of the State, published in the journal aforesaid, we find that from one-half to two-thirds of a crop of the small grains had been harvested on an average in the worst visited section, and drouth and other insects, such as the Hessian-fly had much to do with the poor yield. The eggs were extensively destroyed not only by the Silky Mite, but by the Anthomyia Egg-parasite, and the Ichneumon grub, which I shall describe further on. It was further noticeable that the insects came down with the northwest winds, and that when the wind changed to the south, as it did for several subsequent days, few of the insects returned with it. The great bulk of them were restless and remained till the winds shifted again to the north and northeast. Another noticeable feature was that the eggs were quite generally laid in very moist ground, as there was abundant rain about the middle of August. Throughout the month of September the insects were moving mostly south and southeast, spreading, but very gradually, further and further east. Many of them remained and continued laying till frost.

The fact, that in their previous invasions into Minnesota the locusts had never penetrated farther east in Blue Earth and Nicollet counties than the Minnesota river, led there, to the advancement of a theory that they are peculiar to and thrive only in an alkali region. This is the character of the region west of the Blue Earth river, across which they, seemingly, had never ventured to any extent, and certainly had never prospered.

In answer to an inquiry on the subject last August from Mr. Wise, I stated my

belief that there was no ground for the theory, and that I had more faith in the other causes which I have discussed as limiting the eastward spread of the species. Subsequently the insects extended some distance beyond the river in question. Indeed, they reached a full degree further east than in previous known invasions, extending from Clay county to a little west of St. Paul, and thence to Dodge and Mower counties.

Eggs have been laid more or less thickly over the larger part of the southwest half of the State. Mr. Whitman has carefully mapped out the area, and it includes most of the country southwest of an eastwardly bulging line drawn from Clay to Mower counties, or about four times the territory in which eggs were laid in 1873, and about five times that in which they were laid in 1874 or 1875. It is a singular coincidence, however, (and something similar will be noted in Kansas and Missouri further on), that, as reported by Mr. Whitman, those counties in which the insects hatched in Spring, and where vegetation was mostly consumed, are most nearly free from eggs.

Governor Pillsbury has, from the first, taken a lively interest in the suffering of the farmers from this plague, and by a timely proclamation, setting forth the best known means to be used against them, and in other ways, has done much good. He devoted considerable space to the subject in his last message, and urged legislative action, not only on the part of his own State Legislature, but on the part of Congress. As a result of his efforts, and the liberal policy pursued in having investigations officially continued by Prof. Whitman, the people of the State, by means of organization and ingenious machines, are better prepared to meet the enemy next year than are those of any other State. The legislature also has recently passed two bills which are important in this connection; the one appropriating $75,000 for seed grain to the destitute, the cost of the grain to be assessed against the property of the person receiving it, and paid, as other taxes, in two equal assessments, whenever the recipient shall have raised two crops; the other provides for a bounty of $1.00 per bushel for all grasshoppers caught previous to June 1 next, with smaller compensation thereafter as the insects approach maturity.—(See further on under "Legislation.")

COLORADO.—What with persistent and generally successful fighting by farmers, with burning machines, ditches and coal oil, together with their natural enemies and the heavy rains, the insects that hatched out in Colorado had greatly diminished in June, and those that took wing vanished without leaving any very strong impression as to the direction taken.

During the early part of August the locusts were passing over large parts of Colorado from the north, in a southwesterly direction, at the rate of about fifteen miles a day. They came in successive and almost continuous clouds, and the general opinion was that they came from Wyoming. The small grain was mostly saved throughout the State, but all late and green crops suffered. The *Colorado Farmer* (Denver) of the 10th of August, stated that, while the damage had been great, it was quite probably over-estimated; and the same journal a week later, reported that the insects had very generally left that part of the State. According to Signal Service reports, they had also very generally left by the 13th, but others were passing over from the 22d to the 28th, and thenceforward in diminising numbers. Toward the end of the month they were very thick along the Denver and Rio Grande Railroad, frequently impeding the trains.

The *Georgetown Miner* gives the following account of their drowning in large numbers:

* * * As the ravenous millions were driven up against the high ranges about Mount Evans, they were chilled and commenced falling into the little stream which flows past Sisty's place, until for days, the rivulet was transformed from

a sparkling stream of limpid water, into a floating mass of dead grasshoppers, the water becoming so corrupt and offensive that neither man or beast could tolerate it. The trout pond in Mr. Sisty's meadow became so putrid that he was compelled to cut away the dam and let the accumulated filth flow off. Mr. Sisty says that he never before witnessed such a phenomenon. The theory is, that a cold shower along the range threw down the dense swarms of insects, which were drowned, and the little tributary streams swept them into the brook in such numbers that it required days for the whole to be carried away, while the masses that had accumulated in the eddies, decayed, imparting putridity to the waters.

Mr. Stanger, of the *Colorado Farmer*, tells me that the flight of the great clouds that were far up in the air, was invariably southwest over Denver, and he believes that eggs were laid over the whole traversible territory of the State.

IOWA—As in a few of the S. W. counties in Minnesota, so in adjoining parts of N. W. Iowa, and notably in Osceola and Dickinson counties, the young insects hatched out from eggs laid in 1875; but, as Mr. J. M. Jenkins, of La Mars, writes me, they had entirely disappeared by the middle of June, either dying of inanition, being devoured by their various enemies, or moving off to the N. W.

About the first day of August, the northwestern counties of this State were visited by heavy swarms. They appeared to cross the State line from Dakota and Minnesota at almost exactly the same date for Emmett, Dickinson, Osceola, Lyon, Sioux and Plymouth counties, and from here they swept at once out into the counties lying eastward and a little to the south. The direction of flight was a little south of east, and the rate at times eight or more miles an hour. The insects were at times so thick as to darken the sun, and to impede trains. That the invasion was from the northwest may be readily seen by consulting a map in connection with the following data furnished by Prof. Bessey of the Agricultural College:

Lyon county, commencement of harvest.

Sioux county, July 27.

Plymouth county, last week in July.

O'Brien county, July 27 or 28.

Pocahontas county, August 1.

Cherokee county, August 6.

Monona county, August 10.

Audubon county, about the middle of August.

Harrison county, August 18.

Carroll county, August 18.

Sac county, August 23. Apparently in northwestern part of county about a week or ten days before.

Pottowattamie county, August 23.

Hamilton county, August 30.

Boone county, first week in September.

Hancock county, September 8.

Guthrie county, from 1st to 10th of September.

Story county, first noticed about the middle of September, flying over in considerable numbers.

The amount of damage done, as shown by all obtainable data, was not so great as in former years. Some lucky sections in the area traversed by them escaped entirely; though a few counties, and particularly those first visited, suffered very heavily. The loss to Lyon county was three-fourths, to Sioux, one-half, of all crops. In Plymouth county corn was damaged two-thirds. Monona and Harrison report injury to corn from 10 to 20 per cent. In Pottowatamie county their preference for nursery-stock and garden vegetables made their injury to the grain-grower comparatively slight. This

was the case, also, in Sac county, where they were represented as making raids on garden produce, and leaving corn almost an immunity from attack. O'Brien county reports the destruction of all uncut small grain, garden vegetables and most of the corn. In Cherokee potatoes were damaged about 75 per cent., corn 25 to 33 per cent., and Fall wheat considerably; and in Carroll corn was injured 25 per cent., and cabbages and turnips devoured "in toto". These are the worst cases. Hamilton county suffered a small loss in late potatoes, Fall rye and cabbage; in Audubon the damage did not exceed one per cent., and the counties of Boone, Story and Guthrie almost entirely escaped damage.

The most eastern point reached was in the middle of the State, and the line retreats from Story county both north and south.

In all the counties invaded, eggs were deposited, and in most instances quite thickly.

Prof. Bessey republished the remedies and recommendations in my last Report, and issued them in a little bulletin, that was easily and cheaply sent to farmers throughout the State.

NEBRASKA—Those locusts that came into Iowa earlier in August passed southwest into Nebraska, and, in scattering numbers, reached Council Bluffs and Omaha August 17. A dispatch from Omaha the next day summed up with the statement that: "a general review of the situation was very favorable, and there was no apprehension of a failure to harvest the fine and large crop."

From many other reports it would appear that in the northeast counties, from locusts and other causes, not more than half a crop of corn was saved, but that most of the small grain was duly harvested; and Mr. L. W. Chandler, of St. Helena, wrote, toward the end of the month, that notwithstanding the injury to corn, the country thereabouts was in better shape than it had been for five years.

Almost simultaneously with the incursions in the eastern part of the State, there were others from the north overrunning the western part, and from the 5th of August throughout the month, their movements were reported by the Signal Service. The direction was principally south, or southwest early in the month, and mostly southeast toward the end of the month; and here, as in Minnesota, it was everywhere remarked that when the wind was from the south, the insects remained and awaited a change before passing over in the main direction. The following account from a correspondence of the New York *Tribune*, gives some interesting details:

Early in August they reached the western portions of this State, but were partial in their depredations, devouring everything in some localities, doing little damage in others. On the twelfth of the month they made a forward movement, and appeared in the valleys of the Elkhorn, Platte and Republican. Our local papers, acting on the "ostrich" policy, suppressed the facts or misrepresented them, and all were wishing for a favorable wind to carry the pests beyond our borders. But a soft, southerly wind, varied by an occasional thunderstorm from the northwest, prevailed till the 23d, when, by a stiff northwester, the grasshoppers rose and came from their exhausted feeding-grounds upon the east and south portions of the State. They came literally in clouds, looking like the frost-clouds that drift along the horizon on a winter morning. They are devouring "every green thing," including shade trees and even weeds, such as the "Jamestown weed" and wild hemp. The great body of them seemed to pass south, moving in dense masses during the 23d, 24th and 25th, and will probably be heard from in Kansas and Missouri.

Eggs have been laid all over the eastern part of the State, but less extensively in the western counties. Ex-Governor Furnas thinks that there are few in the counties over one hundred miles west of the Missouri river, and, regarding the young insects next Spring, he remarks, in a recent letter, "that while in the West we have room for

millions more people, and are glad to have them come, and with us occupy and utilize the broad fertile acres God has bequeathed to the Far West, those who have not "sand and grit" enough to clean out a crop of young locusts are not the men wanted! I repeat what I said to you at the Convention in Omaha, and am prepared to demonstrate the truth of the assertion: that any thrifty, energetic farmer can exterminate the most extensive stock of locusts, on any one farm known, with less labor and expense than he can get rid of an ordinary crop of weeds."

Prof. A. D. Williams, of Kenesaw, Adams county, writes:

It is safe to say that eggs were laid in every one of our sixty settled counties. Not one has escaped. But the amount of eggs in the western part of the State, where they appeared earliest, is much less than in the eastern portions of the State. There is undoubtedly a gradual increase of eggs, all the way from the western to the eastern line of the State—the river counties suffering much the more severely. The amount deposited there is beyond all estimation, while west of Kearney there is not a very large amount.

* * * Upon the whole, I incline to the opinion that the casualties of the season, the depredations of the birds and the efforts of the homesteaders will so diminish the number of locusts in the Spring, that small grains will be raised in the western part of the State. But I fear that unless Providence is unusually favorable, and the people bestir themselves unusually to fight the locusts, very little, save corn and late crops, will be raised in the river counties. * * * *

The actual damage done by the locusts last year, in Nebraska, was fully equal to that done in 1874. But the greater abundance of small grains, and the greater reliance of the people upon stock and a more diversified industry, have saved us from the destitution of that year, and largely disarmed *Caloptenus spretus* of his terrors.

KANSAS.—A review of the invasion in Kansas shows it to have been in the main from the north and northwest. The insects came into the northwest part of the State late in July and early in August and were seen flying about in many directions, but mainly southward, during the whole month. Early in September the swarms thickened, and the wind blowing almost a gale from the west on the 7th and 8th of the month, and strong from the west and northwest for two or three days subsequently, the insects during that time swept down in darkening clouds over the greater portion of the State from the 98th meridian to beyond the 96th. The following extracts from my correspondence indicate the nature of the invasion:

I drop you these lines to let you know that the locusts called on us to-day in force. This morning the wind was blowing from the northwest, and as the day advanced the air was filled with a cloud of locusts as thick as any I ever saw before. Toward evening they came down and are resting to-night. They do not manifest much tendency to eat, but may by to-morrow. * * * [Robert Milliken, Emporia, Lyon county, Sept. 9, 1876.

* * * I am sorry to say that the locusts are still with us, more plentiful than I ever saw them before. As I wrote you before, they made their first call on the 9th, and more plentifully on the 11th, the wind blowing from the north and northwest most of the time from the 9th to the 14th; they traveled before it, except when it was too cool for them to fly, as was the case on the 12th and partly the 13th, but on the 14th they were so thick that the cloud fairly darkened the sun. The 16th, 17th and to-day the wind has blown from the south and they have not flown to amount to anything. They are pairing almost universally and are commencing to deposit eggs. Not enough eggs are yet left to make any serious trouble in the Spring, but if they stay another week I tremble for our prospects.—[*Ibid*, Sept. 18, 1876.

The locusts came to the line of the Santa Fé Railroad from Hutchinson as far west as Grenada, about the 25th day of August, 1876, brought by a north by northeast wind. They came in great dark clouds for one day (the 24th) at this place, Sterling, Rice county, Kansas. They mostly passed over here to the south and southwest. A few lit upon us and devoured corn blades, potato leaves and some other toothsome herbage. Little real damage is done as yet to crops. Some of the early wheat is eaten and killed and farmers are generally holding off to sow after the locusts leave. A few returned with south winds, but on the 31st, at 2 P. M., the wind changed to north and

nearly all took wing. But great clouds came fresh from the north and the face of the earth was alive with them. A northeast wind, September 1st, carried the greater part of them with it to some place distant from here. Enough remain to do some damage to vegetation and the south winds bring them back, not in great dark clouds as from the north, but some every day. They seem to float about with the shifting winds, perhaps for food, but when the wind gets north they go in swarms. That shows their tendency to migrate southward. Those that remain are laying eggs.—[H. E. Van Demen, Sterling, Kansas, Sept. 6, 1877.

* * * Such a host of insects I never saw. The gronnd is completely covered and the branches of the trees are bending down with their weight. In my orchard of nearly twenty acres the trees are covered by myriads. Two hundred Siberian crab-apple trees, next to the house, are completely defoliated, and the grove on the north is one huge moving mass.

Our corn crop is splendid, and I think is so far advanced that it will not be materially injured. Thirty acres of wheat which looked beautiful and green in the morning is eaten up. Six hundred and forty acres, two miles south of me, that was looking fine at the beginning of the week, looks this morning as if fire had passed over it. A large acreage has been sown in this county earlier than usual. I suppose it is all gone. —[Jno. W. Robson, Cheever, Dickinson county, Sept. 8, 1876.

Mr. H. A. Brous, a former pupil of mine, who spent the whole Summer in Western Kansas, in company with Prof. B. F. Mudge, kept a careful record of the movements of the locusts, and has sent me the same. From this record it is interesting to note that the western part of the State was just as free in Spring and early Summer of the *Caloptenus spretus* as was the eastern, and that none but the genuine *femur-rubrum* and different species of Œdipoda, and of other genera, were noticed. The first specimens of *spretus* were seen in Wallace county August 5th, flying south from 10 A. M. to 4 P. M. From that time forth they were noticed almost daily flying in different directions, but thickest when from the W. and N. They were most numerous on the 12th and 13th, and on the 24th they were again very thick in Gove county—in both instances flying S. S. W. and S. W. During September the direction also varied, but was most often to S. W. The highest and heaviest swarms were, however, to the S. On a number of days two distinct strata or currents were observed. Thus, on September 1, there was an upper current going W. and a lower one going S. W.; on September 2, an upper S. W., a lower N. W.; on September 9, an upper S. W., a lower S. E. E. In October there were few noticed.

The damage done, though serious enough, was less noticeable than in 1874. Vegetables and Fall wheat suffered most; one extensive wheat-grower (Mr. T. C. Henry, of Abilene,) losing 2,500 acres. A great many farmers sowed again, and plowed the soil under, believing that where not sown early enough to come up in the Fall, it is best that it should not come up till Spring, and that an average crop under such conditions can be grown.

They reached east, according to the records I have at hand, to a line drawn a few miles west of Lawrence, including the larger part of Brown, Doniphan and Atchison in the N. E. corner; portions of Jefferson, Douglas, Franklin, Anderson, Allen and Neosho, and most of Labette, Cherokee and Crawford counties in the S. E. Bourbon, Linn and Miami were only partly overrun; Johnson and Wyandotte escaped entirely, and most of Leavenworth was untouched. In nearly all of the more thickly-settled country invaded, eggs were abundantly laid; and the insects remained laying until buried by the first snows. In the western third of the State, where the insects came earlier, few or no eggs were laid. It will be noticed that the very counties which suffered most in 1875 have here escaped, as is the case in Missouri, and as is the case in Minnesota with the counties ravaged in the Spring of 1876.

MISSOURI—The counties ravaged by the young insects in 1875, had splendid crops in 1876, and the scarcity which I had anticipated (Rep. 8, pp. 120, 156,) of most

noxious insects, including the native locusts and the Chinch Bug, was everywhere noticed and commented upon. The incoming of the winged insects in the Fall was anticipated and feared, as soon as it was known that they were overruning Nebraska and Western Iowa. Feeling the importance of obtaining exact data as to the territory invaded in our own State, and in which eggs were laid, in order to indicate just where injury may be expected, or not, next Spring; I have taken pains to examine, or get reports from, all the western counties. These reports, in condensed form, are herewith submitted; and, summarized, they show that the middle western counties, which suffered most in 1875, (i. e., the portion of the State in which the winged insects reached farthest east in 1874, and laid most eggs) were not overrun in 1876, and will not suffer next Spring. Such are the counties of Platte, Clay, Jackson, Lafayette, Cass, Johnson, Bates, Henry, Pettis and Benton. In these counties the farmers have little or nothing to fear, except as they may receive a few straggling and comparatively harmless bevies of the winged locusts next June and July, from the neighboring country. The counties that were overrun and that will suffer are: 1st, Atchison and Holt, and the western half of Nodaway and Andrew, in the extreme northwest corner. 2d, McDonald, Barry, Jasper, Lawrence, Barton, Dade, Newton, Cedar, Vernon, more particularly in the southwest half; Polk in the northwest third; Hickory in the southwest third; St. Clair in scattering places, and Christian and Greene in the extreme border.

The locusts came into all these counties last Fall, very generally ate off the Fall wheat, and filled the ground with their eggs, in most parts quite thickly. As elsewhere, they continued laying till overtaken by frost.

Bates, according to one correspondent, also received a few of the insects in the western half; while a few stragglers are also reported in Harrison, and even in Gentry, Henry and Cass; but it is evident that in these cases they were not in sufficient numbers to do harm or to cause any forebodings for the Spring. They came into the N. W. corner from the N. and N. W., early in September* and were to some extent prevented from reaching beyond the points indicated, by south winds.

They entered the S. W. counties from the S. W. nearly a month later, invading Newton and McDonald by September 23, and reaching the middle of Barry by the first of October, and Cedar by the middle of this month. It is quite clear that the eastern limit of the swarms which came from the N. and N. W. was receding westward after they reached N. W. Missouri, and that S. W. Missouri, S. E. Kansas and N. W. Arkansas would have escaped had it not been for W. and S. W. winds that brought back insects which had reached south of these points.

The dates of arrival of the insects are nearly a month later than in 1874, and in this respect the 1876 invasion more nearly resembles that of 1866. It was also less immediately disastrous than that of 1874, and most crops were either garnered or beyond injury, and the principal damage was to the Fall wheat, which, as already stated, was eaten down, and in most cases effectually destroyed, at a time, too, when it was generally too late to do anything more than let the ground lie over to plant in corn in Spring.

Various correspondents note that all the holes made by the female were found to contain no eggs when examined, and they argue therefrom that few or no eggs have been laid. From what I said two years ago (Rep. 7, p. 123), and from the philosophy of the process of egg-laying (given further on), it follows that such reasoning is fallacious,

*According to Signal Service Reports some were seen in Nodaway county much earlier.

for all holes left by the female are more or less completely empty, since whenever oviposition has taken place, the hole is filled up.

Locusts, or "grasshoppers," were reported as quite troublesome in Ste. Genevieve and other eastern counties, but they were invariably the common Red-legged species (*femur-rubrum*).

Andrew Co.—If you draw a line about five or six miles west of the One Hundred and Two River and Savannah, about due north and south, it will show the extreme eastern boundary of the locust this year in this county. It will show you, at its northern extremity, a strip of about eight miles east of the Nodaway River infested; while at its southern point it will be only about two miles. A great many eggs are there deposited, but not so many as were left two years ago; nor is there so much alarm felt now as then. The locusts arrived late, yet in time to eat up Fall wheat before the frost arrested their progress. Where I live—four miles east of Bolckow—there were no locusts and no eggs, and we do not feel much alarm for next year.

BOLCKOW, MO., Nov. 26, 1876. R. H. TALBOT.

The locusts visited this county in the Fall, but only the western part. It was late in the Fall when they came. They laid some eggs, but they did no great damage.

WHITESVILLE, MO, Dec. 1, 1876. J. F. SMITH.

The locusts flew into Andrew county in large numbers. They did not go farther east than the center of the county; but in the northwest and western parts they deposited their eggs in great numbers, and the prospect is that next year the supply will exceed the demand. JOHN K. WHITE.

FLAG SPRINGS, MO., Dec. 9, 1876.

The grasshoppers were in the northwest part of this county and did some damage to wheat crops. They deposited some eggs. Injury from them in the Fall was small. J. KIMBERTIN.

ROCHESTER, MO., Dec. 18, 1876.

Atchison Co.—The locusts commenced to drop here the first day of September, coming from the north with the first north wind we had for some time, and commenced depositing their eggs on the fourth, staying with us till the wind got in the north again, when many would leave every clear morning, but only to be replaced in the evening by others. Though their numbers have greatly diminished in the last few days, timothy meadows, pastures, gardens and all available places are full of eggs, in many instances from three to five thousand to the square foot; Fall wheat and turnips are eaten off close to the ground, and what timothy is not already destroyed, will surely be in the Spring when the eggs hatch. C. E. TREADWELL.

ROCKPORT, MO., Sept. 10, 1876.

[Dispatches from various parts of the county show that during the early part of September the insects continually came from the N. W., but poured down in increased numbers on the 11th. By the middle of October the unusually warm weather had about that time caused many of the eggs to hatch.]

The Rocky Mountain Locusts came upon us in September and October. The only damage done by them was to the Fall wheat and rye. They covered the entire county, so far as I could ascertain, depositing their eggs all over it. When they commenced laying, the ground was wet, and they did not appear (as far as my observation extended) to deposit as many eggs as heretofore in their cells—not over half of them having eggs in, and even these being seldom more than half filled. I have heard of some of the eggs hatching out late in the season, but saw nothing of the kind myself. I made examinations some time in the latter part of October, and found what appeared to be the common maggot in the cells, the eggs in the same having the appearance of being spoiled, many being addled or entirely without substance in the shell. There is considerable anxiety among our farmers, as well as in the community generally, as to what they will do the coming season. Much could be done, in my opinion, by concerted action in the early Spring months, in destroying the eggs and the "hoppers" as soon as hatched. If half the time given to grumbling and loafing, in this community, had been spent in active efforts against the "hoppers," in past seasons, and had such efforts been general throughout the grasshopper regions, an immense amount might have been saved to the country. JOHN D. DOPF.

ROCKPORT, MO., Dec. 3, 1876.

Barry Co.—The grasshoppers came into this county about the first of October,

from the west, and extended to the eastern border. As far as they came east they laid eggs. They worked on the wheat-fields. W. F. TUTTLE.
GOLDEN, MO., Dec. 3, 1876.

Barton Co.—The Rocky Mountain Locust made its appearance in this county about the 25th of September last, coming from the south and southwest. They have destroyed the wheat in the southern and western portions of the county, but have not done so much damage north or east. They laid a great many eggs, some of which hatched out before the cold spell we have lately had. A. A. DYE.
LAMAR, MO., Nov. 26, 1876.

I take the earliest opportunity of giving the limited information I am in possession of. The grasshoppers came into the northeast portion of Barton county in small numbers on the 2d of October, from the southwest; and again, in large numbers on the 13th, from the south. They destroyed all the late wheat, but deposited few eggs.
DOYLESPORT, MO., Dec. 9, 1876. J. J. BRYNING.

The grasshoppers did visit our county last Fall. They came from the west, or, perhaps, from the southwest. Came into the western part of the county in destructive numbers about October 20th, arriving at Lamar about two weeks later.

In the southwestern corner of this county the wheat is all, or nearly all, destroyed. In the northwestern corner, early sowed wheat is from one-third to one-half remaining—late sowed wheat is all gone. At Lamar, the destruction is less. In the S. E. corner of the county wheat was much injured. In the N. E. corner wheat was not injured at all. They remained where they first lit down until frozen up in sleet and snow. Large pieces of wheat are less injured than small ones, as the hoppers commenced on the edges and worked toward the center. Farmers could not sow over, as the hoppers remained until cold weather. It is impossible to say how much of the wheat that was eaten off will recover, as the ground froze up and wheat stopped growing as soon as the hoppers died. We *know*, however, that the wheat at the edges is killed, but we cannot tell before growing weather how far in it is killed. I have two large pieces, containing 91 acres, in N. W. corner of county, that I *believe* one-third remains uninjured; while a 13-acre piece, 110 rods long, I *believe* is *all* gone. I believe that most farmers are preparing to sow oats early in the Spring around the edges of their wheat fields, and it is hoped that this course will destroy the eggs. There were comparatively few eggs deposited. WM. H. AVERY.
LAMAR, MO., Dec. 22, 1876.

Bates Co.—No part of this county was visited by the locusts this Fall. The southern part of Vernon was; also, all Barton, Jasper, Newton, McDonald and the western parts of most counties immediately east of those named. They deposited their eggs in all parts visited. G. B. HICKMAN.
MULBERRY, MO., Dec. 14, 1876.

[Addie Haynes, of Rockville, and others, report them to some extent in the western half of the county, and some eggs laid as far east as Butler.]

We have not had, so far as my knowledge extends, any Rocky Mountain Locusts the past season in our county. Our people sowed last Fall a larger number of acres of wheat than they had put in for the previous three years, and all the wheat fields, up to the present time, look very promising for a good crop. CHAS. J. ROBORDS.
HUDSON, MO., Jan. 3, 1877.

Benton Co.—No locusts came into Benton county this Fall.
WARSAW, MO., Nov. 29, 1876. JAMES H. LAY.

The locusts did not, to my knowledge, visit this county in the Fall. If they did at all, it was in the northwest part, and very few. J. H. MAXWELL.
MT. VIEW, MO., Dec. 16, 1876.

Buchanan Co.—No "hoppers" visited any part of this county last Fall, nor do I think they came nearer than twenty miles west of it. M. W. FARRIS.
AGENCY, MO., Nov. 28, 1876.

Cass Co.—There were no locusts in the county during the year.
AUSTIN, Nov. 30, 1876. H. L. HEWITT.

There have been no locusts in this county the present year, for which all good citizens are truly grateful. WM. A. SMITH.

EAST LYNNE, MO., Dec. 3, 1876.

There were a few scattered grasshoppers in this county during the Fall, but I am not sure they were of the Rocky Mountain species. They did no damage and laid no eggs. In fact, depredating insects were remarkably scarce this Fall, except the Flat-headed Apple-tree Borer, which was more numerous than usual.

RAYMORE, MO., Dec. 4, 1876. W. H. BARRON.

A few Rocky Mountain Locusts alighted in the southern border of Cass county, and also in our neighborhood, near Harrisonville; but very few. This was about the end of October and beginning of November. I don't think they laid any eggs in this county; I have seen no signs of them. On the 5th, 6th and 7th of November, I was in the southwestern part of Bates county, and there I saw more of them. I saw that the young wheat was eaten off, and, after hunting a little, I found them huddled in under the blades of the wheat.

Their general course of flying was southeast, and I think it was too late in the season for them to deposit any eggs. DAVID DEFAKAUGH.

RAYMORE, MO., Dec. 18, 1876.

Cedar Co.—The grasshoppers came to this county in October, and remained until the snow came and destroyed them. They laid eggs all the time they were here, and ate all the wheat in the county. G. W. MONTGOMERY.

STOCKTON, MO., Dec. 2, 1876.

The locusts arrived here about the 16th of October, and began at once to bore into the ground and deposit their eggs. They chose the hardest ground they could find, seeming to prefer that which was sandy or gravelly. They continued coming for two weeks, and would average one to every square foot of the whole ground. They devoured about nine-tenths of the wheat in this, the south part of the county. They came from the southwest. W. SMILEY.

STOCKTON, MO., Dec. 2, 1876.

Locusts were here in vast numbers, laying eggs and destroying nearly all the wheat. C. W. JORDAN.

WHITEHARE, MO., Dec. 9, 1876.

Caldwell Co.—No injury from locusts in this county, and no eggs laid.

GOULD FARM, MO., Dec. 23, 1876. C. L. GOULD.

Clay Co.—No part of our county was visited by locusts the past season.

HARLEM, MO., Nov. 30, 1876. J. C. EVANS.

The Rocky Mountain Locusts did not make their appearance in this vicinity at any time during the year 1876. An occasional straggler could be seen during September and October. None but close observers noticed them. DAN. CARPENTER.

BARRY, MO., Nov. 30, 1876.

Dade Co.—The locusts came the first week in October in sufficient force to destroy about all of our Fall wheat. They laid eggs, which, in dry spots, hatched out, and the young hoppers have been killed by the frost. R. A. WORKMAN.

GREENFIELD, MO., Dec. 11. 1876.

DeKalb Co.—DeKalb county has not been visited by the Rocky Mountain Locust this year. G. E. SHULZ.

HAVANA, MO., Dec. 2, 1876.

Gentry Co.—A few scattered grasshoppers were seen passing over the county this Fall, but none stayed. They were flying very high in air, and to the southwest.

MT. PLEASANT, MO., Dec. 3, 1876. CHARLES S. WHITESCARVER.

One flight of locusts passed over this county. Wind from the N. W. A few stayed here. No deposit of eggs.

GENTRYVILLE, MO., Dec. 16, 1876. HUGH STEVENSON.

There were a few Rocky Mountain Locusts along the western part of the county, but they stayed only a few days, and deposited no eggs. LEVI LONG.
ISLAND CITY, MO., Dec. 29, 1876.

Greene Co.—There were no hoppers in Greene county, except in the S. W. corner, where they came too late to do much harm. Some passed over to Christian Co. and did some injury. In Lawrence Co., also, they did considerable mischief.
SPRINGFIELD, MO., Dec. 23, 1876. F. F. FINE.

Harrison Co.—Only a few straggling grasshoppers fell into this county the past season; they deposited no eggs. Their nearest approach, in large numbers, was about 40 miles west of us. JOSEPH WHITELEY.
NEW CASTLE, MO., Dec. 4, 1876.

There has not been any locusts or grasshoppers in this county this fall.
EAGLEVILLE, MO., Dec. 4, 1876. COL. H. FITCH.

There were no locusts in either Harrison or Mercer counties the past year.
CAINSVILLE, MO., Dec. 1, 1876. J. H. BURROWS.

Henry Co.—The locusts did not get to our county this year. They reached the counties South and West of us. We have a few, remaining from a year ago, that seem to be acclimated, and they are enough, with our native hoppers, to eat considerable wheat; but the weather is good for their destruction this Fall. T. J. QUICK.
GAINES, MO.

A few Rocky Mountain Locusts came to this, the eastern part of Henry Co.; but I have seen none, neither have I heard of any depositing their eggs.
LEESVILLE, MO., Dec. 12, 1876. J. E. STRINGER.

Hickory Co.—The locust came into the southwest part of this county in the latter part of September. They did little or no damage, as they came in late, and were but few in number. I do not believe they laid any eggs here. Our native locusts, this Summer, were fewer than I have ever seen them, and I have lived on a farm in Missouri since 1849. W. L. SNIDOW.
ELKTON, MO., Dec. 7, 1876.

Not any part of Hickory county was visited by the grasshoppers, nor any part of this (Cass Co.) They have been South of us in Vernon, Cedar, Polk and parts of St. Clair counties, depositing eggs. C. J. HOSTETTER.
EAST LYNNE, Cass Co., MO.

Holt Co.—The grasshoppers (*Caloptenus spretus*) commenced their flight over us to-day at 12 o'clock M., going in a southeasterly direction. Wind is blowing from the North, which is very favorable for them in their journey this way. They are not in very great numbers as yet; but are reported as being in immense numbers in the North part of the county. J. W. MAPLE.
OREGON, MO., Sept. 8, 1876.

The *spretus* are daily increasing in numbers here, taking all the wheat and rye sown in the county. They are depositing eggs. To-day they are going N. W. Wind South. J. W. MAPLE.
OREGON, MO., Sept. 26, 1876.

The pests are still with us, and are now depositing their eggs by the million. Some report that a small white worm is killing them, but I have been unable to find any up to this time. Some of the eggs are now hatching in North parts of the county.
OREGON, MO., Oct. 12, 1876. J. W. MAPLE.

Many of the grasshopper eggs have been destroyed by a small white worm, and many have been washed out and destroyed by exposure to the weather. The grasshopper limits extend about 5 miles east of the Nodaway River, in Andrew Co.
OREGON, MO., Dec. 2, 1876. J. W. MAPLE.

The locusts have spread all over this county, and have deposited their eggs in vast quantities, though perhaps less than in '74. I examined many of their perforations, and in some localities found at least three-fourths empty; in the others, from 12 to 20 eggs. A few passed over here the 25th of August, and occassionally thereafter, until the 20th September, when they came in large numbers. They had destroyed, by the 25th of September nearly all the wheat and rye in the county. On the 26th they were first noticed laying eggs here. A few were noticed on the 11th of November, some on the ground, others flying North. Many farmers have resown their devastated fields, and will no doubt profit by so doing. Some say that worms and bugs have been destroying the eggs, also that the eggs have been hatching out in exposed places. The experience of some of our farmers is against turning the eggs under in the Fall or Spring.

OREGON, MO., Nov. 29, 1876. WM. KAUCHER.

The grasshoppers were all over this county, and laid more eggs than they did two years ago, the ground being literally filled with them.

BIGELOW, MO., Dec. 2, 1876. J. H. CROW.

From examination made in various parts of the county by several farmers and others, the eggs of the locusts seem to be rotted. This is ascribed to the wet weather, we had some few weeks ago. CLARKE IRVINE.

OREGON, MO., Dec. 3, 1876.

The Rocky Mountain locusts came here last Fall in September; they came from the North, and deposited their eggs in great quantities; some stayed till cold weather killed them, and some wenton South. Some say their eggs have turned to worms and will not hatch, which might be the case, for I noticed, myself, some worms in the cells, but whether they were deposited by the hoppers, or not, I am unable to say.

FORREST CITY, MO., Dec. 18, 1876. J. D. WHITE.

The locusts extended all over our county. They came from the N. W. about September 20th. The ground is fuller of eggs than ever before. All the wheat was taken up; rye also. A few resowed, but it makes no show. They stayed here until frozen to death. BENNET KING.

OREGON, MO, Dec. 25, 1876.

Jasper Co.—The grasshoppers or locusts came here October 2d, and again on the 3d, 5th, 8th and 9th. Ten years ago they reached three miles east of here, now, they are several miles still further east. No doubt in a week the wheat will be all destroyed, as, indeed, most of it is already. They came from the southwest. Wind south. They did no damage here in the Springs of 1867 and 1875. THOS. McNALLIE.

SARCOXIE, MO., Oct. 14, 1876.

The grasshoppers made their appearance in this county again on the 2d of October. The wind was blowing from the southwest during the day. About noon they came into the city; the sky was darkened with them. They soon covered the entire county, and at once began their onslaught upon the wheat fields. Jasper county farmers had put in more wheat than they had ever done before; the season being favorable, it was making rapid growth, and the future looked encouraging with promises of a large wheat crop. In a few days, scarcely a spear of wheat was to be seen over the entire county. However, at the close of November they began to leave; and large quantities of them were found dead; many seeming to have been destroyed by an insect. They deposited eggs, some of which hatched out during the warm days in November. In some of the late sown fields the wheat seems to be starting again; and some farmers have resown portions of their fields, in the hope that a favorable Winter will secure a crop. The eastern line seems to have extended to the west of Green county. JOSIAH TILDEN.

CARTHAGE, MO, Nov. 20, 1876.

On the 2d of October the grasshoppers made their first appearance here, coming from southwest and going northeast, in such numbers as to, in a measure, obscure the sun's rays. They stayed here in millions, until killed by cold; eating up all growing wheat and green grass. The ground was perforated in all directions with innumerable holes, and I suppose they deposited eggs in great abundance. We are in the eastern part of the county, a few miles from the Lawrence county line.

REEDS, MO., Dec. 8, 1876. J. M. THORNBURG.

Myriads of grasshoppers were passing over Granby, from southwest to northeast,

on Sunday and Monday, the 8th and 9th. A glance upward towards the sun revealed them filling the air as far as vision could extend, as thick as snowflakes in a storm, and they drifted along with the breeze, and fluttered down at your feet occasionally, or lit on your nose, with as much unconcern as if they had been a part of the elements. The bushes and sides of the road were speedily thick with them.—*St. Louis Republican*, Oct. 1, 1876.

The locusts were all over the county in great numbers. They laid a great many eggs, but as most of them hatched out this Fall, I apprehend no trouble next Spring. They came in September, and stayed until killed by frost. No wheat recovered, as far as I know. Farmers generally resowed, but the wheat has not come up.
SMITHFIELD, MO., Dec. 26, 1876. WM. G. L. CRIAG.

The wheat that was eaten off did not recover. Very few farmers have resown. There will be no wheat crop in this and adjoining counties this year. Next Fall there will not be much sown on account of scarcity of seed, and dread of the hopper. Some farmers are contemplating a crop of oats on their wheat ground; others, flax and barley. J. M. PETERSON.
January 2, 1877.

Jackson Co.—There were no Rocky Mountain locusts in this county the past Fall, and, per consequence, no eggs deposited. Chinch bugs were seen in the early Fall.
HICKMAN MILLS, MO., Dec. 4, 1876. W. S. PARRISH.

The grasshoppers did not deposit any eggs here; only a few straggling ones, and they perhaps of native species made their appearance. JACOB GREGG.
STONY POINT, MO., Dec. 10, 1876.

Johnson Co.—The Rocky Mountain locust failed to visit us the past season. A few were noticed very high in the air, passing over with the wind, but none alighted. We have no chinch bugs at all this season, owing, perhaps, to the fact that the small grain was totally destroyed by the hoppers in 1875. But such other pests as usually trouble us were very numerous and destructive. D. B. REAVIS.
KINGSVILLE, MO., Dec. 4, 1876.

No grasshoppers came here this season. They appeared in Barton county in October, though not in great numbers, and west of that county, in Kansas, for a hundred miles, they were very numerous, and depositing their eggs, at the end of September. W. A. CAMPBELL.
HOLDEN, MO, Nov. 27, 1876.

There were no grasshoppers in our county this Fall. There may have been some at the southwest corner of the county, but I do not think so.
WARRENSBURG, MO., Dec. 8, 1876. J. L. CLELAND.

FAYETTEVILLE—None. J. L. MOTSINGER.

Lafayette Co—Lafayette county has not been visited this year by the Rocky Mountain locust. J. BELT.
LEXINGTON, MO.

No locusts came into this county the past season, or into Jackson county either.
SNI-A-BAR, MO., 1876. J. T. FERGUSON.

Lafayette Co.—There were a few of the genuine Rocky Mountain locusts with us during the latter part of September, and beginning of October; but they were so few in number as to pass almost unnoticed, and were supposed to be stragglers, from a flight that passed down through Kansas, depositing a vast number of eggs as far South as Montgomery county, in that State. If those that were in this county laid any eggs, they were so few as not to be observed, and it is my opinion that none were deposited. As to what part of the county was invaded, it would be hard to tell, as they were so few in number; and the fact that they mix up with the natives, adds to the difficulty.
AULLSVILLE, MO., December 10, 1876. JAS. E. GLADISH.

Lawrence Co.—The locusts came into this county about the 5th of October. Their course was North. A small portion of the southeast part of the county was not visited by them, and there the wheat crops are not hurt; but they spread over all other parts,

eating up thousands of acres of wheat. Some farmers have resown, but many have not. They deposited their eggs by the acre, choosing, strange to say, the hardest and most gravelly places to lay them in. I found, on examination, just at the setting in of Winter, that very many of the eggs had so far advanced as to resemble small white maggots. The hoppers have penetrated considerably farther East this year in this county than they have ever done before. W. S. GOODMAN.
MT. VERNON, MO., December 12, 1876.

McDonald Co.—The Rocky Mountain locust visited all parts of McDonald county, and deposited their eggs very liberally, some of which hatched out before the cold set in. W. D. POLSON.

Newton Co.—First saw the grasshopper here on September 29. On Sunday the sky was full of them, going East. From here to Joplin they are everywhere; to-day the ground is covered, and the air filled with them. They are at Granby. Farmers are afraid to sow wheat. G. C. BROADHEAD.
NEOSHO, MO., October 7, 1876.

Grasshoppers came into the west part of this county in large numbers on the 23d of September, and soon extended all over it. They came from Northwest at first, but soon they came from all parts, as the wind blew. They would rise and fly off in the fore part of the day, and a new lot would come in at night. They continued very numerous till the sleet storm in November, which killed them; and they filled the ground with eggs; some of which hatched out, and some were destroyed, but plenty yet remain. JOHN THRASHER.
NEOSHO, MO., December 7, 1876.

The locusts came into all parts of this county in vast swarms, and laid large quantities of eggs; every batch of land that was bare, and not too hard, is filled with them, and some few have hatched out this Fall. W. H. WETHERELL.
SENECA, MO., December 6, 1876.

Nodaway Co.—The Grasshoppers came into this county from the Northwest on 11th of September, and left, going southwest, on the 26th of October. They spread over about two-thirds of the county, but the northeast they did not reach, and that part remained uninjured. They deposited eggs, but not so many as was expected from their numbers. Many fields of wheat in the western part of the county were entirely destroyed. The greatest damage was done to fall grain and meadows.
PICKERING, MO. M. B. W. HARMAN.

The locust came into the west or northwest portion of our county late in the Fall. In the extreme West they laid eggs, and devoured the Fall wheat.
LUTESTON, MO., December 14, 1876. WM. H. CLARK.

The grasshoppers were in the northern and western portions of this county last Fall, but did little damage. They laid eggs, but opinions differ as to the probability of their hatching out next Spring. Many contend that some kind of insect has destroyed them, as, repeatedly, when the holes in which they were deposited were dug into, no eggs were found. T. D. WALLACE.
HOPKINS, MO., December 3, 1876.

Pettis Co.—A few grasshoppers came into this county last Fall, but I do not think they laid any eggs. They did no damage. J. K. P. IDOL, M. D.
HOUSTONIA, MO., November 30, 1876.

The Rocky Mountain Locust did not visit any part of Pettis county during the year 1876. O. A. CRANDALL.
SEDALIA, MO., December 11, 1876.

Platte Co.—No locusts here this year. Sixty miles north and west is as near as they came to us. JAMES ADKINS.
PLATTE CITY, MO., Dec. 1, 1876.

No locusts in our county this Fall; a few are reported to have fallen from a great height, carried out of their course by adverse winds. R. P. C. WILSON.
PLATTE CITY, Mo, December 1, 1876.

Polk Co.—The locusts came into our county last Fall at a late date. They did not get so far East as this in large quantities; but at the western border of the county they were numerous, though I have been unable to ascertain whether or not they deposited any eggs; but they came so late that I hardly think they did. T. W. WILSON.
PAYNE'S PRAIRIE, Mo., December 18, 1876.

In the three western townships of this county the hoppers have damaged the wheat badly, and have deposited large numbers of eggs, They have been very destructive in the eastern part of Dade and Cedar county. J. CARSON.
BOLIVAR, Mo., December 15, 1876.

No wheat was eaten off in this immediate vicinity. I do not think any attempt was made to resow; the damage was done too late. I hear of no measures being taken to protect wheat or other grain from the threatened ravages. T. W. SIMPSON.
PAYNE'S PRAIRIE, Mo., December 30, 1876.

The locusts visited the western portion of this county some time last Fall, in October or November, I believe, and did considerable damage to a few fields of young wheat; though I think they were found only in a few isolated spots. Don't know whether they laid eggs or not. H. CARR PRITCHETT.
MORRISVILLE, Mo., January 6, 1877.

The locusts visited the western townships of our county, Jackson, Madison, and Johnson. They made their appearance between the 1st and 10th of October, and came from the West. They filled the ground with eggs. Where most numerous they entirely destroyed the growing wheat. J. M. LOAFMAN, M. D.
MORRISVILLE, Mo., December 27, 1876.

Ray Co.—No part of our county was visited by the Rocky Mountain locusts during the year. W. R. MEADOR.
HARDIN, Mo., December 29, 1876.

St. Clair Co.—The locusts dropped in here in very small numbers late in October. The wind was from the north as they were coming in, and carried the greater part to Texas; only those that had tired out staying with us. They laid eggs, and injured the wheat somewhat. I hear that they have eaten all the wheat from Sac River south to Arkansas. It is very cold just now, and no hoppers visible.
COLLINS, Mo., Dec. 2, 1876. WM. H. FILLERY.

But very few Rocky Mountain Locusts came into the county this year. None to do any damage to crops. South of us, in Barton, part of Cedar and Polk counties, they are reported to have destroyed the wheat crops in places. JOHN HILL.
TABORVILLE, Mo., Dec. 6, 1876.

Vernon Co.—The locusts visited the southwestern portion of our county this Fall, doing much damage to wheat. They deposited a vast number of eggs, yet the deposits were not so numerous in proportion to the number of insects as in former years—say fifty per cent. M. L. MODREL.
LITTLE OSAGE, Mo., Dec. 9, 1876.

They came into the south and west half of Vernon in great numbers, and, it is said, deposited eggs as usual. Very few appeared in the northeast part, and no eggs deposited there. J. A. PURINTON.
SCHELL CITY, Mo., Dec. 2, 1876.

No damage sustained in northeast part of this county. But few made their appearance. In the Spring of 1875, the young appeared in immense numbers, but unaccountably disappeared from this locality before half grown, and did no damage.
SCHELL CITY, Mo., Dec. 23, 1876. J. A. PURINTON.

The grasshoppers destroyed every field of wheat with which they came in contact, beyond recovery. On account of the lateness of the season farmers are letting their wheat lands lay over for corn, in the Spring. M. L. MODREL.
LITTLE OSAGE, Mo., Jan. 8, 1877.

INDIAN TERRITORY.—They were thick over most of the Territory, passing southward, from the middle of September, and many of them remaining through the season. They rendered horse-back travel extremely unpleasant.

TEXAS—The swarms reached Texas from the North and West about the middle of September, and from that time forth till Winter were flying very generally, over the State, reaching eventually latitude 29°, or more definitely to the Gulf all the way from the Sabine river to Austin. Their course was almost due South, and their injury confined to succulent vegetables, shrubs and fruit trees, the Orange and Cotton suffering more particularly.

Mrs. H. S. King, of Austin, writes:

The cars for about ten days were so much obstructed on the Texas Central line as to necessitate their stopping occassionally to clear the track of the grasshoppers. Though there were millions, they were never sufficiently numerous to obscure the sun, even for an instant, and they have been, as they usually are at this season, comparatively harmless to vegetation. For about six weeks they would fly up in the promonaders' face like a pelting rain, alighting on the head and clothes, or taking short flights in advance of him.

They were especially thick on walls, fencetops, and tree trunks, remaining there torpid until the sun shone out, and during the heat of the day swarming high in air, when they look like snow-flakes, wafted by changing breezes.

Messrs. Nelson and Sadler, of Galveston, state that the insects occurred all along the line of the Texas Central Railroad. It was most noticeable, as Mr. Jno. M. Crockett, of Dallas, assures me, that notwithstanding the wind was, on the 19th September, and for a few days thereafter, when the heaviest flights occurred, from N., N. E.; it yet varied much during the invasion, blowing mainly from the S. E. Nevertheless the insects made steady progress southward, succeeding best on calm days and not diverging E. five miles in fifty. Contrary winds simply baffled them and brought them to the ground until the conditions permitted them to continue their course.

Eggs were laid throughout the territory overrun, and the young hatched in large quantities during the mild weather of February. Up to the time this writing goes into the printer's hands, (March 5, 1877), the young, which have numerously hatched near the Gulf, have been destroyed by heavy cold rains that occurred the latter part of February.

ARKANSAS—The insects overran the extreme N. W. corner of this State, as indicated in my map, and were particularly bad in Benton county. Indeed the injury was mostly confined to this county and the region south of it, the insects not extending east to Carroll county. This is the first recorded instance of their reaching into Arkansas. They made their advent from the 7th to the 15th of October, coming with the wind from the N. W. and flying S. and S. E., until they struck the base of Boston Mountain. As in our own S. W. counties, wheat was greatly injured by them, and eggs were laid up to the time Winter set in.

From the foregoing record, summed up from numerous reports and observations, it is manifest that the locusts that hatched and did more or less damage in Minnesota early in the year, endeavored to get away to the northwest as soon as they got wings. They were subsequently repulsed and borne back again by the winds to their hatching places ; thence south and southwest into Iowa and Nebraska. As

they rise and fly from day to day they concentrate and condense, since in passing over a given area during the hotter parts of the day new accessions are constantly being made to the flying hosts which, with serried ranks, descend in the afternoon. Thus, in returning, the swarms were thicker and more destructive in places than they were in leaving. Yet it is evident that the column which thus came back to Minnesota and passed to the south and southwest was more straggling than in 1874, and that by the middle of the month it had spent its force and left eggs throughout most of the country traversed. Had the invasion consisted of these only, the damage would have been but slight, and the insects would hardly have reached into Kansas. Their eggs, laid in August, were far more liable to injury and to premature hatching than those laid later. But it is clear that fresh swarms that hatched in Dakato, and further northwest, followed on the heels of the Minnesota swarms, passing over much of the same country to the east and southward into Colorado, and eventually overruning the larger part of Nebraska and Kansas, the Western half of Iowa and some of the Western counties in Missouri, and reaching into Indian Territory, Texas and parts of Arkansas.

The extent of the region invaded will appear by referring to the map (Fig. 16). Coming generally later than in 1874, they did less damage, and the farmers were in so much better condition to withstand injury, that it was much less felt. In most sections visited, part of the migrating hosts remained to lay eggs; and the invasion of 1876 is remarkable as compared to that of 1874, for the large extent of country supplied with eggs. Another fact is notable, viz: that the very parts of Minnesota in which eggs were laid in 1875, and the portions of Missouri and Kansas in which they were most thickly laid in 1874, escaped in 1876. I cannot believe, however, that this is anything more than coincidence.

DESTINATION OF THE DEPARTING SWARMS OF 1875.

In considering this subject a year ago, I expressed the belief—founded on observation and the records as far as made—that the swarms which left the country south of the 44th parallel and the 100th meridian passed to the N. W., reaching into N. W. Dakota, Wyoming and Montana. I was unable at the time to state whether or not they reached up into British America, and from the large per centage of the departing insects that were diseased and that dropped on the way, I was led to the following conclusions:

> We may very justly conclude that a large proportion of the insects which departed from the country invaded in 1874, perished on their way toward the native habitat of the species, and that those which did not perish reached the Rocky Mountain region of the Northwest whence their parents had come the previous year. They struggled back

with thinned and weakened ranks, and it will probably take many years ere they become so prodigiously multiplied again, and are enabled by favorable conditions to push so far east as they did in the year 1874. They did some harm at their resting places on the way, but in a large number of instances they rose after their brief halts, without doing serious injury. Nor can I learn of any instances where these swarms that left our territory deposited eggs. Had the winds been adverse to their northwestern course, and obliged them to remain in the country where they hatched, I believe that the bulk, if not all of them, would, nevertheless, have perished before laying eggs.—[Rep. 8, p. 108.

Information gathered during the past year shows conclusively that the insects which left the Mississippi Valley in 1875 did reach into British America. The *Winnepeg Standard* of August 19, 1876, as quoted by Professor Whitman, says:

The locusts which hatched in Missouri, Kansas and Nebraska, in an area of 250 miles from east to west, and 300 miles from north to south, took flight in June, and invariably went northwest, and fell in innumerable swarms upon the regions of British America, adjoining Forts Pelly, Carlton and Ellice, covering an area as large as that they vacated on the Missouri River. They were reinforced by the retiring column from Manitoba, and it seemed to be hoping against hope that the new swarms of 1876 would not again descend upon the settlements in the Red River valley. Intelligence was received here that the insects took flight from the vicinity of Fort Pelly on the 10th of July, and then followed a fortnight of intense suspense.

Professor G. M. Dawson, of Montreal, writes: "You may be interested in knowing that the northward flying swarms in 1875 penetrated a considerable distance into the region west of Manitoba, while most of the insects hatching in the latter Province went southeastward when winged, and that large numbers got at least as far east as the Lake of the Woods." In an interesting paper in the *Canadian Naturalist,* on the "Appearance and Migrations of the locusts in Manitoba and the N. W. Territories in the Summer of 1875," Professor Dawson further gives many other valuable records, some of which, as bearing on the question under consideration, I quote entire, as they will hardly bear condensing:

From the reports now received from Manitoba and various portions of the Northwest Territory, and published in abstract with these notes, it would appear that during the Summer of 1875 two distinct elements were concerned in the locust manifestation. First, the insects hatching in the province of Manitoba and surrounding regions, from eggs left by the western and northwestern invading swarms of the previous autumn; second, a distinct foreign host, moving, for the most part, from south to north. The locusts are known to have hatched in great numbers over almost the entire area of Manitoba, and westward at least as far as Fort Ellice on the Assineboine river (long. 101° 20′), and may probably have been produed, at least sporadically, in other portions of the central regions of the plains; though in the Summer of 1874, this district was nearly emptied to recruit the swarms devastating Manitoba and the Western States, and there appears to have been little if any influx to supply their place. Still further west, on the plains along the base of the Rocky Mountains, from the 49th parallel to the Red Deer river, locusts are known to have hatched in considerable numbers—but of these more anon.

Hatching began in Manitoba and adjacent regions in favorable localities as early as May 7th, but does not seem to have become general till about the 15th of the month, and to have continued during the latter part of May and till the 15th of June. * * *

The destruction of crops by the growing insects, in all the settled regions was very great, and in many districts well nigh complete. The exodus of these broods began in the early part of July, but appears to have been most general during the middle and latter part of that month, and first of August. The direction taken on departure was, with very little exception, southeast or south. It is to be remarked, that as there does

not seem to have been during this period any remarkable persistency of northwest or northerly winds, the insects must have selected those favoring their intended direction of migration, an instinct which has very generally been observed elsewhere.

* * * * * * * * *

Foreign swarms from the south crossed the 49th parallel with a wide front stretching from the 98th to the 108th meridian, and are quite distinguishable from those produced in the country, from the fact that many of them arrived before the latter were mature. These flights constituted the extreme northern part of the army returning northward and northwestward from the States ravaged in the autumn of 1874. They appeared at Fort Ellice on the 13th of June, and at Qu'Appelle Fort on the 17th of the same month, favored much no doubt by the steady south and southeast winds, which, according to the meteorological register at Winnipeg, prevailed on the 12th of June and for about a week thereafter. After their first appearance, however, their subsequent progress seems to have been comparatively slow, and their advancing border very irregular in outline. They are said to have reached Swan Lake House—the most northern point to which they are known to have attained—about July 10; while Fort Pelly, further west, and nearly a degree further south, was reached July 20th, and about seven days were occupied in the journey from there to Swan River Barracks, a distance of only ten miles.

We thus learn that vast swarms not only reached into British America in 1875, from our own country, but that the young hatched there from swarms that had come the previous year from the further northwest.

There was, therefore, north of the 49th parallel, a repetition of the devastation we were at the time experiencing; the insects hatching there in bulk just about the time they were leaving Texas on the wing.

SOURCE OF THE SWARMS OF 1876.

From the preceding statement of facts, and from the detailed history of the invasion of 1876, it becomes obvious that this invasion was made up, 1st, of such insects as hatched out in southwest Minnesota, and parts of Colorado, Wyoming and Dakota; 2d, of additions to these from Montana and British America. In how far those in either of these categories were made up of the progeny from the insects that left our country in 1875 we shall never be able accurately to determine. The proportion of parasitized and diseased insects that left Missouri, doubtless became less among those which hatched and rose from the farther north and west, and we may, I think, take it for granted that the larger part of the swarms that reached Montana and British America, laid eggs. In addition to the vast bevies which invaded the northwest from the south and southeast, there were in 1875, as Prof. Dawson shows, others that hatched in the northwest, pouring from British America into our Northwest territory. There were, in fact, in Manitoba, and large parts of the Northwest, two grand opposing movements of the winged insects, which thus replaced each other. And bearing this in mind, we can understand the increased area in the Northwest over which eggs were laid that year, and from which the 1876 swarms had their source. As no eggs were laid in Manitoba, while the young are known to have abounded in the moun-

tain region to the west of that province, it is more than probable that the principal source of the 1876 invasion was Montana and the Saskatchawan and Swan River countries. The question as to how far the northwest breeding grounds are recruited by the insects which hatch in the more fertile country which I have designated as outside the species' natural habitat, is a most interesting one; for if thus recruited there is all the greater incentive for us to exterminate the young insects which hatch with us. All such questions can only be settled by a thorough study of the subject by a properly constituted commission, charged by Congress with the work.

EASTERN LINE REACHED.

A study of the eastern limit of the invasion of 1876, compared with that of 1874, shows that it is peculiar in reaching farther east in Minnesota and Iowa, and farther south and east in Texas. The limit-line—extending from Clay county, Minnesota; bulging toward St. Paul, reaching southwardly to the center of Iowa; thence westwardly receding to Lawrence, Kansas, and bulging again to Southwest Missouri—is more irregular between the 36th and 46th parallels than it was in 1874. On an average, however, it does not extend east of the 94th meridian.

RATE AT WHICH THE INSECTS SPREAD.

Leaving Montana about the middle of July the insects reached far into Texas by the end of September, thus extending about 1,500 miles in 75 days, or an average of about 20 miles per day. But over a large part of this territory, viz., portions of Wyoming, most of Dakota and Nebraska, W. Minnesota, N. W. Iowa, N. W. Kansas, and N. E. Colorado—they appeared almost simultaneously, or during the last few days of July and the first few day of August; and this, I think, indicates that they were at that time swept down at a very much higher rate by the N. W. winds from Montana and British America. After that time the extension S. was tolerably rapid, but the extension E. was more and more slow. They occupied nearly a month reaching from N. W. Iowa to the S. W. limit in the same State, and their eastward progress on the confines of the limit line already indicated was still more gradual as they went South. All of which indicates that they fly most powerfully when leaving the higher altitudes of the N. W., and most persistently during the first week or so after becoming fledged, while the females are not yet prompted to descend for oviposition. This is also the period when they are passing over the vast plains and the sparsely settled and uncultivated portion of the country, in which there is, perhaps, least inducement for the ravenous host to halt.

As flight is not consecutive day after day, but often impeded by bad weather, and as it is not continuously in one direction, the average rate is not more than 20 miles a day. It is also most variable and at times reaches a maximum of between two and three hundred miles daily.

DIRECTION OF FLIGHT.

The wind was quite changeable during the period of invasion, and we find the insects, at one time or another, traveling in nearly all possible directions, except due west. Yet, if we except the departing swarms which flew from N. W. Minnesota in July, the direction of the invading hosts was, as I believe it always has been and always will be, conspicuously S. and S. E. The exceptions were principally during the first week in August, when they swept S. W. from Minnesota over parts of Iowa and Nebraska; and two months later when they were carried N. E. into our S. W. counties.

INFLUENCE OF THE WIND IN DETERMINING THE COURSE OF LOCUST SWARMS.

That excessive multiplication and hunger are the principal causes of migration from the native home of the species, and that the prevailing winds determine the course therefrom, I have endeavored to show (Reps. 7, p. 104; 8, p. 112). That all these influences very largely determine the return migration when the insects hatch out in the Mississippi Valley is also doubtless true; and it is interesting to note in this connection that, according to observations, covering a period of from two to five years, furnished by General Myer, at the request of Dr. A. S. Packard, Jr.,* the prevailing winds in May and June, within the region subject to invasion, are from the Gulf of Mexico, or from the S. E. and S., *i. e.* in the opposite direction, prevails later in the season. Yet, to assume that the migrations are solely dependent for direction on the winds would be incorrect, as there is cumulative evidence (much of it recorded in these Reports) that when once the migration has commenced, adverse winds only retard, but do not materially change its course.

LOCUST FLIGHTS EAST OF THE MISSISSIPPI.

To the unscientific mind there are few things more difficult of apprehension than that species, whether of plants or animals, should be limited in geographical range to areas not separated from the rest of the country by any very marked barriers, or by visible demarcations. Yet it is a fact well known to every naturalist, and the geo-

* "The Destructive Locust of the West," *Am. Naturalist*, Vol. XI, p. 27.

graphical distribution of species forms at once one of the most interesting and one of the most important studies in natural history. Some species have a very limited, others a very wide range; and while in the course of time—in the lapse of centuries or ages—the limits have altered in the past and will alter in the future, they are, for all practical purposes, permanent in present time. These limits may in fact, for the purpose of illustration, be likened to those which separate different nations. Though frequently divided by purely imaginary lines, the nations of Europe, with their peculiar customs and languages, are well defined.

Along the borders where the nations join, there is sometimes more or less commingling; at other times the line of demarkation is abrupt; and in no case could emigrants from the one, long perpetuate their peculiarities unchanged in the midst of the other. Yet in the battle of nations, the lines have changed, and the map of Europe has often been remodeled. So it is with species. On the borders of the areas not abruptly defined, to which species are limited, there is more or less modification from the typical characters and habits; while in the struggle of species for supremacy, the limits may vary in the course of time. The difference is, that the boundaries of nations result from human rather than natural agencies, while those of species result most from the latter, and are threfore more permanent. These remarks apply of course to species in a natural state and where their range is uninfluenced either directly or indirectly by civilized man.

I found some difficulty at the late Conference of Governors at Omaha to consider the locust problem, in satisfying those present that the Rocky Mountain Locust could not permanently thrive south of the 44th parallel, or east of the 100th meridian, and that there was no danger of its ever extending so as to do serious damage east of a line drawn a little west of the centre of Iowa. They could not see what there was to prevent the pest from overrunning the whole country, and thought that Congress should be appealed to, not only on behalf of the country that has suffered fromits ravages, but on behalf also of the whole country that is threatened therefrom.

Having discussed in my two previous Reports the native home of the species, and the conditions which prevent its permanent settlement in the country to which it is not native, it is unnecessary here to go into detail on these points. Briefly, the species is at home and can come to perfection only in the high and dry regions of the Northwest, where the Winters are long and cold and the Summers short; and whenever it migrates and oversweeps the country to the south or

southeast, in which it is not indigenous, the changed conditions are such that the first generation hatched out in that (to it) unnatural climate, either forsakes it on the wing or perishes from debility, disease and general deterioration. On the soundness of this conclusion depends the future welfare of most of the more fertile States between the Mississippi and the mountains, and science, as well as past experience, show it to be sound. Upon this hypothesis the people of nearly the whole country so scourged during the past year, and so threatened next Spring, may console themselves that the evil is but temporary: they may have to fight their tiny foe most desperately next Spring, but they have also the assurance that even if he prove master of the field, he will vacate in time to, in all probability, allow of good crops of some of the staples, and that he may not return again for years. On the other hypothesis—for which there is only apparent, and no real reason—ruin stares them inevitably in the face.

The causes which limit the eastward flight of the winged swarms that come from the Northwest are, with the majority of people, still more difficult to appreciate; for most persons can see no reason why a swarm that overruns the western portions of Minnesota, Iowa and Missouri, should not extend to the eastern borders of the same States, or into Illinois, Indiana, Ohio and eastward. Having previously considered the more occult climatic influences that bear on the belief that they never will, I need only state here, that the principal arguments rest in the facts that—1st, the power of flight of any insect that has a limited winged existence, must somewhere find a limit; 2d, that all past experience has shown that *Caloptenus spretus* has never extended, in a general way, beyond the limit indicated, and that as long as the present average conditions of wind and climate prevail, it is reasonable to suppose that it never will.

One of the principal difficulties in the way of a proper apprehension of the facts, is found in the failure, in the popular mind, to discriminate between species. The ordinary newspaper writer talks of *the* grasshopper, or *the* locust, as though all over the country and all over the world there was but one and the same species. One of the Governors present at the Conference referred to, was at first fully of the belief that our Rocky Mountain pest came all the way from Asia. In the case of this destructive species, even some entomologists have added to the difficulty by erroneously claiming that it is common all over the country to the Atlantic ocean.

The above thoughts were suggested by the following reports, that met my eye, in the *Cincinnati Gazette* of the 24th of October, from Dayton and Hamilton, respectively, in the State of Ohio:

The advent of Kansas grasshoppers, over Sunday and until Monday evening, in great numbers throughout the city, is a most remarkable incident. They were found early Sunday morning, and left, as suddenly as they came, on Monday evening.

A shower of mammoth grasshoppers came down upon our town and vicinity on Saturday night. We have never seen such large ones before, and we understand from old citizens, that they are entire strangers in this part of the country. We saw a boy have a string tied to two of them (which were as long as a man's finger) trying to drive them, and he succeeded pretty well.

A flock of grasshoppers alighted in Hamilton about 11 o'clock on Saturday night, from the northwest. Those that were not drowned in the river or killed by the heavy rain, were probably gobbled up before Sunday night by the chickens.

[Fig. 17.]

AMERICAN ACRIDIUM.

Such reports as these very naturally confirm the unscientific in the idea that the locust plague of the West, or so-called "Kansas grasshopper," has overstepped the limits entomology ascribes to it, and is upsetting the conclusions which I have come to. The same swarm passed over Oxford in the same State, in a southwesterly direction, and fortunately that veteran and well-known apiarian, the Rev. L. L. Langstroth, who has not forgotten to be a close observer, had specimens sent to me. They proved to be the American Acridium (*Acridium Americanum*). As stated in my 8th Report, this is one of the largest and most elegant of our N. A. locusts, the prevailing color being dark brown, with a pale yellowish line along the middle of the back when the wings are closed. It has a wide range, hibernates in the winged condition, and differs not only in size and habits from the Rocky Mountain Locust, but entomologically is as widely separated from it as a sheep from a cow. It is a species common over the country every year, and during exceptional years becomes excessively numerous and acquires the migratory habit, its wings being long and well adapted to flying. As I learn from Dr. S. Miller of Franklin, it passed in swarms over part of Johnson county, Missouri, late in September; and it was everywhere abundant in 1876.

The following extracts from letters of correspondents refer to this species:

I send you by Mr. Shaw a small package containing specimens of locusts, destructive about Chattanooga and in all eastern Tennessee. They strike me as nearly allied to the Rocky Mountain Locust; fly with the same noise and shine of wings, in large shoals, but are larger.—[Dr. G. Engelmann, Warm Springs, N. C., Aug. 29, 1876.

We have a locust here which has in some places occurred in considerable numbers, and some people think it the same as the one which has produced so much damage in the West. This I doubt, as it is evidently a native species.—[E. M. Pendleton, Prof. of Agriculture, Un. of Ga., Atlanta, Ga., Sept. 14, 1876.

The American Acridium visited us on the night of November 21, (Saturday.) A rain fell during the night. Cambridge City, Indiana, was also visited by them on the same night.—[Herschel I. Fisher, Eastham College, Richmond, Ind.

Toward the end of July the unfledged insects did an immense amount of damage to the cotton and other crops of Georgia and South Carolina. The papers were full of graphic accounts of their destruction, and editors not only very generally took it for granted that they had to do with the western *spretus*, but Mr. T. P. Janes, Commissioner of Agriculture for Georgia, in his circular No. 27, supposed they were the same. Specimens which he subsequently sent me, however, at once revealed their true character.

The damage done by some of the more common locusts that occur over the country, is, let me repeat, sometimes very great, especially during hot, dry years. In some of the New England States their ravages have, in restricted localities, fairly equalled those of the voracious *spretus* of the West. But while a few of them, under exceptional circumstances, develop the migratory habit, they none of them ever have, and in all probability never will, compare to *Caloptenus spretus* in the vastness of its migrations and in its immense power for injury over extensive areas.

Whenever we hear of locust flights east of the Mississippi, we may rest satisfied that they are not of our Rocky Mountain pest, and are comparatively harmless.

DOES THE FEMALE FORM MORE THAN ONE EGG-MASS ?

Whether the female of our Rocky Mountain Locust lays her full supply of eggs at once, and in one and the same hole; or whether she forms several pods at different periods, are questions often asked, but which have never been fully and definitely answered in entomological works. It is the rule with insects, particularly with the large number of injurious species belonging to the Lepidoptera, that the eggs in the ovaries develop almost simultaneously, and that when oviposition once commences, it is continued uninteruptedly until the supply of eggs is exhausted. Yet there are many notable exceptions to the rule among injurious species, as in the cases of the common Plum Curculio and the Colorado Potato-beetle, which oviposit at stated or irregular intervals during several weeks, or even months. The Rocky Mountain Locust belongs to this last category, and the most casual examination of the ovaries in a female, taken in the act of ovipositing, will show that besides the fully formed eggs then and there being laid, there are other sets, diminishing in size, which are to be laid at future periods. This, I repeat, can be determined by any one who will take

the trouble to carefully examine a few females when laying. But just how often, or how many eggs each one lays, is more difficult to determine. With *spretus* I have been able to make comparatively few experiments, but on three different occasions I obtained two pods from single females, laid at intervals of 18, 21 and 26 days respectively. I have, however, made extended experiments with its close congeners, *femur-rubrum* and *Atlanis*, and in two cases, with the former, have obtained four different pods from one female, the laying covering periods of 58 and 62 days, and the total number of eggs laid being 96 in the one case and 110 in the other. A number of both species laid three times, but most of them—owing, perhaps, to their being confined—laid but twice. They couple with the male between each period, and I have no doubt but that, as in most other species of animals, there is great difference in the degree of individual prolificacy.

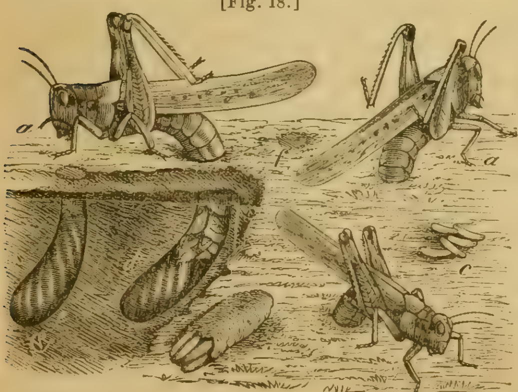
We may, therefore, feel tolerably confident that the Rocky Mountain Locust will sometimes form as many as four egg-pods.

The time required for drilling the hole and completing the pod will vary according to the season and the temperature. During the latter part of October or early in November last year, when there was frost at night and the insects did not rouse from their chilled inactivity until 9 o'clock A. M., the females scarce had time to complete the process during the four or five warmer hours of the day; but with higher temperature not more than from two to three hours would be required.

HOW THE EGGS ARE LAID.

The question as to how best to treat the soil, or to manage the eggs so as to most easily destroy their vitality, is a most important and practical one, and as assisting to a decisive answer, I have carried on a series of experiments, which will be presently detailed. To make the experiments the more intelligible, I will first give the reader a deeper insight into the philosophy of the processes of egg-laying and of hatching than I have hitherto done, and this the more readily that it has never been given by any other author.

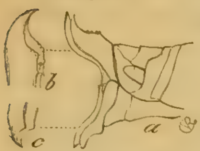
[Fig. 18.]



ROCKY MOUNTAIN LOCUST:—*a*, *a*, *a*, female in different positions, ovipositing; *b*, egg-pod extracted from ground, with the end broken open; *c*, a few eggs lying loose on the ground; *d*, *e*, shows the earth partially removed, to illustrate an egg-mass already in place, and one being placed; *f*, shows where such a mass has been covered up.

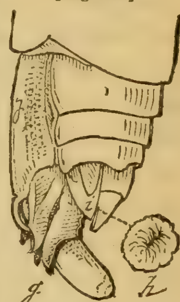
I have already explained (Rep. 7, p. 122) how, by means of the horny valves at the end of her abdomen (Fig. 19) the female drills a cylindrical hole in the ground in which to consign her eggs. The curved abdomen stretches to its utmost for this purpose, and the hole is generally a little curved and is always more or less oblique, (Fig. 18, *e. d.*) If we could manage to watch a female during the arduous work of ovipositing we should find that, when the hole is once drilled, there commences to exude at the dorsal end of the abdomen, from a pair of spónge-like exsertile organs (Fig. 20, *h*) that are normally retracted and hidden beneath the super-anal plate, (Fig. 20, *i*) near the cerci, a frothy, mucous matter, which fills up the bottom of the hole. Then, with the two pairs of valves brought close together, an egg would be seen to slide down the oviduct (*j*) along the ventral end of the abdomen, and, guided by a little finger-like style,* (*g*) pass in between the horny valves (which are admirably constructed, not only for drilling, but for holding and conducting the egg to its appropriate place) and issue at their tips amid the mucous fluid already spoken of. Then follows a period of convulsions, during which more mucous material is elaborated, until the whole end of the body is bathed in it—when another egg passes down and is placed in position. These alternate processes continue until the full complement of eggs are in place, the number ranging from 20 to 35, but averaging about 28. The mucous matter binds all the eggs in a mass, and when the last is laid the mother devotes some time to filling up the somewhat narrower neck of the burrow with a compact and cellulose mass of the same material which, though light and easily penetrated, is more or less impervious to water, and forms a very excellent protection. (Fig. 21, *d.*)

[Fig. 19.]



Rocky Mountain Locust:—Anal characters of female, showing horny valves.

[Fig. 20.]



Oviposition of Rocky Mountain Locust.

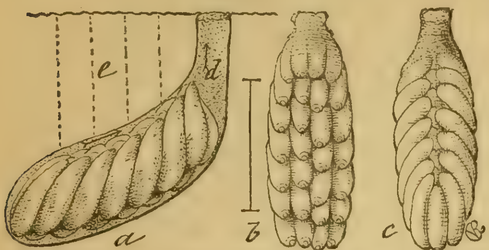
PHILOSOPHY OF THE EGG-MASS.

To the casual observer the eggs of our locust appear to be thrust indiscriminately in the hole made for their reception. A more careful study of the egg-mass or egg-pod will show, however, that the female took great pains to arrange them, not only so as to economize as much space as possible consistent with the form of

*This is a simple process or extension of the sternite, not particularized, that I am aware of, by any author. It may be known as the egg-guide or *gubernaculum ovi*.

each egg, but so as to best facilitate the escape of the young locust; for as the bottom eggs were the first laid and are generally the first to hatch, their issue would, in their efforts to escape, disturb and injure the other eggs, were there no provision against such a possibility. The eggs are, indeed, most carefully placed side by side in four rows, each row generally containing seven. They oblique a little, crosswise of the cylinder. (Fig. 21, *a*). The posterior or narrow end which issues first from the oviduct is thickened, and generally shows two pale rings around the darker tip (Fig. 22, *a*). This is pushed close against the bottom of the burrow which, being cylindrical, does not permit the outer or two side rows to be pushed quite so far down as the two inner rows; and for the very same reason the upper or head ends of the outer rows are necessarily bent to the same extent over the inner rows—the eggs when laid being somewhat soft and plastic. There is, consequently, an irregular channel along the top of the mass. (Fig. 21, *c*) which is filled only with the same frothy matter which surrounds each egg and occupies all the other space in the burrow not occupied by the eggs. The whole plan is seen at once by a reference to Figure 21, which represents enlarged, a side view of the mass within the burrow (*a*), and a bottom (*b*) and top (*c*) view of the same, with the earth which adheres to it, removed.

[Fig. 21.]



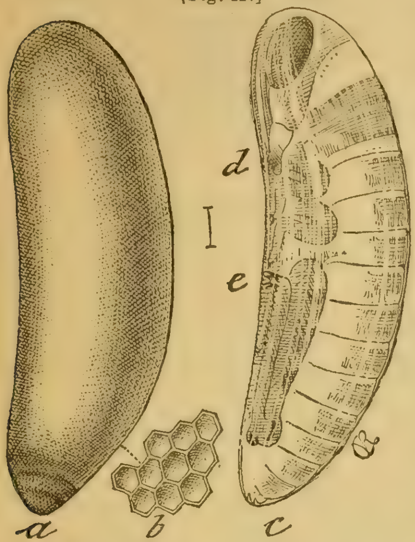
EGG-MASS OF ROCKY MOUNTAIN LOCUST:—*a*, from the side, within burrow; *b*, from beneath; *c*, from above—enlarged.

HOW THE YOUNG LOCUST ESCAPES FROM THE EGG.

Carefully examined, the egg-shell is found to consist of two layers. The outer layer which is thin, semi-opaque, and gives the pale cream-yellow color, is seen by aid of a high magnifying power to be densely, minutely and shallowly pitted; or, to use still more exact language, the whole surface is netted with minute and more or less irregular, hexagonal ridges (Fig. 22, *a*, *b*). The inner layer is thicker, of a deeper yellow, and perfectly smooth. It is also translucent, so that, as the hatching period approaches, the form and members of the embryon may be distinctly discerned through it. The outer covering is easily ruptured, and is rendered all the more fragile by freezing; but the inner covering is so tough that a very strong pressure between one's thumb and finger is required to burst it. How, then, will the embryon, which fills it so compactly that there is scarcely room for motion,

succeed in escaping from such a prison? The rigid shell of the bird's egg is easily cracked by the beak of its tenant; the hatching caterpillar, curled within its egg-shell, has room enough to move its jaws and eat its way out; the egg-coverings of many insects are so delicate and frail that the mere swelling of the embryon affords means of escape; those of others so constructed that a door flies open, or a lid lifts by a spring, whenever pressure is brought to bear: in some, two halves open as in the shell of a muscle; whilst in a host of others the embryon is furnished with a special structure, called the egg-burster, the office of which is to cut or rupture the shell, and thus afford means of escape. But our young locust is deprived of all such contrivances, and must use another mode of exit from its tough and sub-elastic prison. Nature accomplishes the same end in many different ways.

[Fig. 22.]



EGG OF ROCKY MOUNTAIN LOCUST:—*a*, showing sculpture of outer shell; *b*, the same very highly magnified; *c*, the inner shell just before hatching; *d*, *e*, points where it ruptures.

She is rich in contrivances. Every one who has been troubled by it must have noticed that the shanks (tibiæ) of our locust, as of all the members of its family, are armed with spines. On the four anterior legs, these spines are inside the shank; on the long posterior legs, outside. The spines of the hind shanks are strongest, and the terminal ones on all legs stronger than the rest. There can be no doubt that these spines serve to give a firm hold to the insect in walking or jumping; but they have first served a more important pre-natal purpose.

When fully formed, the embryon is seen to lie within its shell, as at Fig. 22, *c*. The antennæ curve over the face and between the jaws, which are early developed, and, with their sharp, black teeth, reach onto the breast. The legs are folded up on the breast, the strong terminal hooks on the hind shanks reaching toward the mesosternum. Now the hatching consists of a continued series of undulating contractions and expansions of the several joints of the body, and with this motion there is slight but constant friction of the tips of the jaws and of the sharp tips of the hind tibial spines, as also of the tarsal claws of all the legs against the shell, which eventually weakens

between the points *d* and *e*, and finally gives way there. It then easily splits up to the eyes or beyond, by the swelling of the head.

By the same undulating movements the nascent larva soon works itself entirely out of the egg, when it easily makes its way along the channel already described, without in the least interfering with the other eggs, and finally forces a passage-way up through the mucous filling in the neck of the burrow (Fig. 21, *d*). Once fully escaped from the soil, it rests from its exertions, but for a short time only. Its task is by no means complete: before it can feed or move with alacrity it must molt a pellicle* which completely encases every part of the body. This it does in the course of three or four minutes, or even less, by a continuance of the same contracting and expanding movements which freed it from the earth, and which now burst the skin on the back of the head. The body is then gradually worked from its delicate covering until the last of the hind legs is free and the exuvium remains, generally near the point where the animal issued from the ground, as a little, white, crumpled pellet. Pale and colorless at first, the full-born insect assumes its dark-gray coloring in the course of half an hour.

From this account of the hatching process, we can readily understand why the female in ovipositing prefers compact or hard soil to that which is loose. The harder and less yielding the walls of the burrow, the easier will the young locust crowd its way out.

The covering which envelops the little animal when first it issues from the egg, though quite delicate, undoubtedly affords protection in the struggles of birth from the burrow, and it is an interesting fact that while it is shed within a few minutes of the time when the animal reaches the free air, it is seldom shed if, from one cause or other, there is failure to escape from the soil, though the young locust may be struggling for days to effect an escape.

While yet enveloped in this pellicle, the animal possesses great forcing and pushing power, and if the soil be not too compact, will frequently force a direct passage through the same to the surface, as indicated at the dotted lines, Fig. 21, *e*. But it can make little or no headway, except through the appropriate channel (*d*), where the soil is at all compressed. While crowding its way out, the antennæ and four front legs are held in much the same position as within the egg, the hind legs being generally stretched. But the members bend in every conceivable way, and where several are endeavoring to work through any particular passage, the amount of squeezing and crowding they will endure is something remarkable. Yet if by chance the

* This pellicle (the *ambion*) is common to most Orthopterous and Neuropterous insects.

protecting pellicle is worked off before issuing from the ground, the animal loses all power of further forcing its way out. The instinctive tendency to push upwards is also remarkable. In glass tubes, in which I have had the eggs hatching in order to watch the young, these last would always turn their heads and push toward the bottom whenever the tubes were turned mouth downward; while in tin boxes where the eggs were placed at different depths in the ground, the young never descended, even when they were unable to ascend on account of the compactness of the soil above.

ADDITIONAL NATURAL ENEMIES.

The enemies of the Rocky Mountain Locust may be divided into those which destroy the eggs and those which attack and destroy the active insects.

Animals which destroy the eggs.—In addition to the Black-bird and Prairie Chicken, previously mentioned as feeding on the eggs, Mr. Geo. F. Gamner, of Lawrence, Kans., has found the Lapland Longspur (*Plectrophanes lapponicus*), the Horned Lark (*Eromophila cornuta*) and the Quail doing the same good work, feeding especially on such eggs as are exposed by freezing and thawing. Mr. J. W. Robson, of Cheever, Kans., has found the Skunk and Striped Squirrel destroying large numbers of the eggs, and the *Greeley* (Col.) *Sun* reports five acres of land dug all over by the former animal in search of them. The Silky Mite (*Trombidium sericium*), the habits of which were related in my 7th Report, did much good in destroying the eggs in the more northern States. In parts of Minnesota it reduced them to a powder over extensive areas, and as the power of these minute scarlet bodies for good as egg-destroyers has been questioned, I give the following reports, which tell their own story:

Last evening, when we reached Worthington from Lake Shetek, there was quite an excitement in Worthington, owing to the fact that the citizens were generally convinced that a red parasite was destroying the grasshopper eggs. I examined the matter carefully myself, and became convinced that the destruction of the eggs in that immediate vicinity was well assured; but I determined not to write you and excite any hope until a further and more complete examination could be had. We therefore furnished our Bohemian friends with a bottle of the eggs and *their pests*, and the commission left in high spirits. We postponed further investigation until this morning, when I left and prosecuted the examination with vigor. The farmers in the vicinity knew nothing of these signs of deliverance until the visitors from Worthington reached them, and I feel safe in saying to you that in a circle of ten miles from Worthington there will scarcely be an egg left by to-morrow night. I send you a bottle herewith containing the cones and the parasites. We could scarcely find a cone or sack, except as they were indicated by the parasite on the surface; and each cone, which was not entirely destroyed, had from five to fifty of the red laborers at work upon the eggs. We found scores of cells with no eggs left, except the shells.

* * * * * * * * * * *

I stopped for fifteen minutes one-and-a-half miles west of Wilder, where Section Foreman Smith took me to that portion of his farm where eggs were deposited. We could find none by general digging, but wherever we found, as we frequently did, the red parasite on the surface, we found the cone beneath, with the parasite at work con-

suming the eggs. * * * I am aware that two years ago this parasite was found working upon the eggs at Madelia and other places, but here we have the remedy almost as soon as the eggs are laid, while in the former instances the parasite was only discovered in the Spring.—[Letter from Ex-Gov. Stephen Miller, written from Windom, Minn., Aug. 15, 1876.

We send herewith a box of grasshopper eggs, together with the "silky mite," of which so much has been said. You can see a sample of the work they are doing. They are over the ground and in it wherever eggs have been laid. They suck the eggs, leaving the bare shell. We have talked with farmers from all parts of the county, and they all tell the same story—not a cell to be found that is not partially or wholly destroyed.

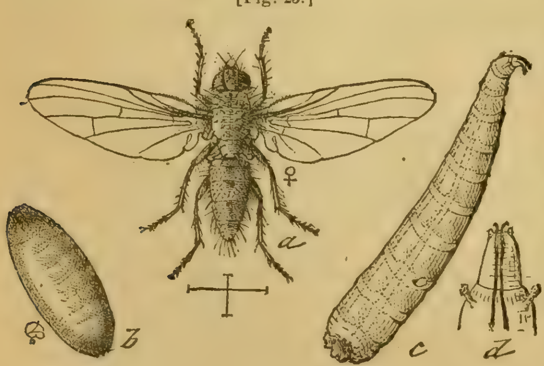
We have personally inspected them in more than twenty different places, and are satisfied that in this county the eggs of the festive G. H. are a "total wreck." Allow us to suggest that you call for a report from every county in the State that has been infested by them.—[Letter to *Pioneer Press and Tribune*, from Bell & Gruelle, Worthington, Nobles Co., Minn., Aug. 16, 1876.

I send, enclosed in a circular tin box, mailed with this, some dirt containing grasshopper's eggs, and also the *red mite* or *spider* that sucks them, as you will perceive on examination. I trust they will be received in good order. I send them at the request of A. Whitman, of St. Paul, of this State, with whom I am corresponding sometimes on this grasshopper matter.—[Letter from R. B. Potts, U. S. N., Worthington, Minn., August 18, 1876.

Up to the past autumn the Silky Mite was the only parasite that was known to attack the eggs of our locust, though a small Chalcid-fly* had been bred by Mr. S. H. Scudder, from those of the Carolina Locust, a large species with blue and black hind wings; and two Ichneumon-flies were known to attack locust eggs in Europe. The present year five new insect enemies have been found attacking these eggs almost everywhere throughout the infested country, and these I will proceed to describe.

THE ANTHOMYIA EGG PARASITE, (*Anthomyia radicum*, var. *caloptenі.*)—This is by far the most wide-spread and generally useful of the different egg enemies. It has occurred in Minnesota, Iowa, Nebraska, Kansas, Missouri and Texas, and wherever I have examined the locust eggs, whether in Missouri, Kansas or Nebraska, I have found it destroying on an average about ten per cent. of them. It is the enemy referred to by Mr. Jno. D. Dopf, of Atchison, and by Mr. J. D. White, of Holt county, in the reports from Missouri,

[Fig. 23.]



ANTHOMYIA EGG-PARASITE:—*a*, fly; *b*, pupa; *c*, larva from side; *d*, head of same from above—enlarged.

*A similar, if not the same Chalcid, infests the eggs of *spretus*, for Mr. Potts has sent me egg-masses in which every egg had a Chalcid pupa. Unfortunately, they were too dry when received to permit of rearing the imago.

(ante, pp. 68, 72.) and the following items will serve as samples of many others that referred to the same parasite:

Recently a white worm or maggot has been discovered in the locust eggs laid in this vicinity, and so generally are the grubs that we really look for a great diminution in next year's locust crop. About the time the hoppers began laying eggs we had a hard, soaking rain, and since then we have had several more—the last this morning. By this time the ground is well soaked with water and the eggs were and are laid in earth that is quite moist. It is about two weeks since the hoppers first reached Mankato, they have laid many eggs, and already this worm or maggot has developed and seems to be on the increase, being found in the egg cells, where it sucks or destroys the egg. Some cells that I have opened have had two and three worms in them.—[From a letter from J. C. Wise, Mankato, Minn., August 20, 1877.

On the ninth I sent you a box of locust egg parasites, and to-day I will send you some more of different sorts or different stages of development or both. I find them more plentiful to-day than before. The ground seems to be full of them from 5 to 20 of the small white worms in a single cell, one generally, though sometimes two of the large white ones in a cell. The reddish covered ones I suppose are in a different stage of development, though the same parasite. In every cell in which I have found any of those sent you the eggs were nearly or quite destroyed. But there is another, and a far more destructive enemy, viz: the hot sun, which is hatching them out by the million, though the parasites may continue their work after it ceases to operate. I shall be happy to do all I can to aid you in your investigations—[Letter from C. E. Treadwell, Rockport, Atchison county, October 16, 1876.

Yesterday we discovered on a warm southern exposure that our locust eggs were hatching out maggots. We break open the cocoons and the eggs on exposure to the sun for a few moments crawl away a worm. In warm places along the hedges the earth is alive with them. Is this a new development of the locust question? It would seem to be a confirmation of the theory you promulgated, as I understood it, at the time. I secured a few of the perfect cocoons which I enclose for your examination. We suppose these will do as the others do upon exposure to the sun.

The people here are quite excited over the matter, hoping it may be a solution of the problem for next year, at least, and have deputed me to lay the matter before you. Any information you can give us in regard to this our latest development, will be thankfully received and acknowledged—[Letter from S. M. Pratt, M. D., Hiawatha, Brown county, Kansas, October 30, 1876.

Various reports have been circulated in regard to the destruction of the eggs of the Rocky Mountain Locust (Caloptenus spretus) by a worm. I am happy to state that these reports were substantiated yesterday by Mr. McLockhead of Deer Creek, Kanawaka, twelve miles west of this city, who brought me a box of earth in which the eggs of the "hopper" had been abundantly deposited. To-day a similar box was secured from W. B. Barnett, Esq., of Hiawatha, Brown county. In both of these instances a large proportion of the eggs have been destroyed by a small, white larvæ. Many of the egg-cases, which ordinarily each contain from twenty to thirty eggs, had no eggs in them, but were full of these worms or larvæ, each one of which took the place of an egg which it had destroyed. Some of the egg-cases contained only two or three larvæ with more than twenty sound eggs. I consider these to be the larvæ of a parasitic Hymenopterous insect [it was subsequently verified as the Anthomyia under consideration] which I hope to obtain in the winged or perfect state, if I succeed in carrying them safely through their transformation—[Prof. F. H. Snow, in *Lawrence* (Kansas) *Journal*, November 1, 1876.

This good little friend, which simultaneously prevailed over so large an extent of country, is a small white maggot, (Fig. 23, *c*) of the same general form of the common meat maggots or "gentiles," but measuring, when full grown and extended, not quite ¼ of an inch in length. The head, with some of the anterior joints of the body, tapers and is retractile, and the jaws consist of two small hooks joined to a V-shaped, black, horny piece which, as it is retracted or extended, plays beneath the transparent skin. The hind or tail end

is squarely docked off, and contains two small yellowish-brown, eye-like spots, which are the principle spiracles or breathing pores.

These small maggots are found in the locust egg-pods, either singly or in varying numbers, there sometimes being a dozen packed together in the same pod. They exhaust the juices of the eggs and leave nothing but the dry and discolored shells, and where they are not numerous enough to destroy all the eggs in the pod, their work, in breaking open a few, often causes all the others to rot.

When fed to repletion this maggot contracts to a little cylindrical, yellowish-brown pupa, (Fig. 23, *b*) about half the length of the out-stretched and full-grown larva, and rounded at both ends. From this pupa, in the course of a week in warm weather, and longer as the weather is colder, there issues a small, grayish, two-winged fly, (Fig. 23, *a*) about ¼ of an inch long, the wings expanding about ½ of an inch, and in general appearance resembling a diminutive house-fly, except that the body is more slender and more tapering behind, and the wings relatively more ample. More carefully examined, the body is seen to be of an ash-gray color, tinged with rust-yellow, and beset with stiff bristle-like hairs, those on the thorax stoutest, and those on the abdomen smaller but more uniformly distributed. The wings are faintly smoky and iridescent. There are three dusky longitudinal stripes on the thorax, most distinct anteriorly, and another along the middle of the abdomen, most distinct in the male, which also differs from the female in the larger eyes, which meet much more closely on the top of the head than in the female, and in the face being whiter.

The Winter is passed mostly in the pupa state, though doubtless in some cases also in the winged state.

The flies of this genus are characterized by the shortness of the antennæ, and by the attenuated abdomen. The characters given to it are, however, by no means uniform, and as the species generally bear a very close resemblance to each other, and there have been a large number described in Europe, (many of them very imperfectly), it becomes almost an impossibility to properly determine them. As the sexes often differ materially, it is also, except where they are reared from the larva, difficult to connect them, and as the colors often become sordid and dull in the cabinet, many of the described species have no real existence.

The flies frequent flowers, and often congregate and play in swarms in the air. Their eggs are white, smooth, oval, about 0.04 inch long, and are dropped near the food of the larva. In the larva state these insects mostly feed on leguminous plants, and the carnivorous habit is exceptional. The species affecting the Cabbage, the Onion, the

Radish etc., have received different names as *brassicæ*, *ceparum*, *raphani*, etc., but several of them doubtless constitute but one species. A comparison of those reared from the locust eggs with the descriptions of *brassicæ* and *ceparum* has not enabled me to discover any constant differences, and they should perhaps all be referred to *radicum* Linn. At all events I feel that it is safest to define the insect under consideration merely as a variety of that species, leaving the proper determination of it to the future monographer of the genus.

The probabilities are that, feeding normally on the roots of various plants, it found locust eggs to its liking, and multiplied rapidly as a result of the abundance of such eggs.

ANTHOMYIA RADICUM (Linn.) var. CALOPTENI—*Egg*—Oval, smooth, white, 0.04 inch long.

Larva—Skin unarmed, 0.24 inch long when extended, of the normal form, the mandibular hooks black, quite conspicuous, and diverging at base. Prothoracic spiracles elongate. Anal spiracles minute, yellowish-brown, with the 8 fleshy surrounding tubercles, small.

Pupa—Pale-brown, rounded at each end, with the prothoracic spiracles and lips anteriorly, and the anal spiracles and lower tubercles posteriorly, showing as minute points.

Imago—♀. Average expanse 0.48 inch. General color ash-gray with a ferruginous hue, especially above, and a more or less intense metallic reflection. Face with white reflections below; eyes smooth, brown, encircled by the ground color, and this behind and on forehead bordered by a brown line; 2 similar lines at back of head from upper corners of eyes and approaching to neck; forehead dusky-brown, becoming bright yellowish-red toward base of antennæ, and the brown forking at right angles around occiput. Trophi and antennæ black, the style simple and somewhat longer than the whole antennæ. Thorax with three dusky longitudinal lines, obsolete behind; legs black, with cinereous hue beneath; wings faintly smoky, with brown-black veins, the discal cross-vein straight and transverse, the outer one bent and more oblique; balancers crumpled, yellowish. Abdomen with faint dusky medio-dorsal spots, broad at base, tapering and obsolescing toward end of each joint.

In the ♂, aside from the larger eyes, stronger bristles, and narrower, less tapering abdomen with its additional joint—all characteristic of the sex—the face is whiter, and the medio-dorsal dark mark of abdomen continuous.

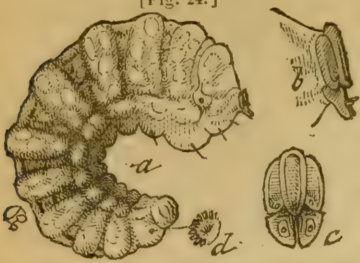
Described from 25 specimens of both sexes, reared from locust-egg-feeding larvæ.

Specimens bred from cabbage and raddish roots, and others in my cabinet taken from the burrows (made in Osage Orange in Missouri) of *Crabro stirpicola* Pack.; do not differ specifically.

THE COMMON FLESH FLY (*Sarcophaga carnaria*, L.)—The red-tailed variety (*sarraceniæ*) of this ubiquitous insect, described and figured in my 7th Report (p. 180) as preying on the locust, also attacks its eggs. It is a larger maggot than the preceding, and contracts to a darker pupa which is not similarly rounded at each end, but has the hind end truncate, and the front end tapering. It sucks the eggs, as does the Anthomyia larva, but the parent fly is probably attracted to those, principally, which are addled or injured, as the pods in which I have found it have very generally been in a fluid state of decay. From three quarts of eggs I have obtained 26 of these flies.

UNDETERMINED SPECIES.—Next to the Anthomyia Egg-parasite, in importance, is a much larger, more sluggish, yellowish grub, (Fig. 24) measuring about ½ an inch when extended, which is found within or beneath the locust eggs, lying in a curved position, the body being bent so that the head and tail nearly touch each other. It is a smooth grub, with a very small, brown, flattened head, with the joints near the head swollen and the hind end tapering, and with deep, translucent sutures beneath the joints, which sutures show certain vinous marks and mottlings, especially along the middle of the back. It exhausts the eggs, and leaves nothing but the shrunken and discolored shells. It has not yet been reared to the perfect state, but from the structure of its mouth it is evidently Hymenopterous, and will produce, without much doubt, some Ichneumon-fly. It has been found in Minnesota, Iowa, Kansas and Missouri, and has destroyed about one per cent. of the eggs.

[Fig. 24.]



UNDETERMINED EGG-PARASITE OF R. M. LOCUST.

The following letters refer to this species:

The other day as I was strolling through the fields, I stopped to examine some eggs. I found the ground in spots quite full of white grubs, worms or maggots, whatever they may be called. Many of them were in the egg-pods, busy at work. I collected a few, and sent to you in a small vial by mail for your examination. The ground was high and dry where found.—[From S. D. Payne, Kasota, Le Sueur county, Minn., Sept. 28, 1876.

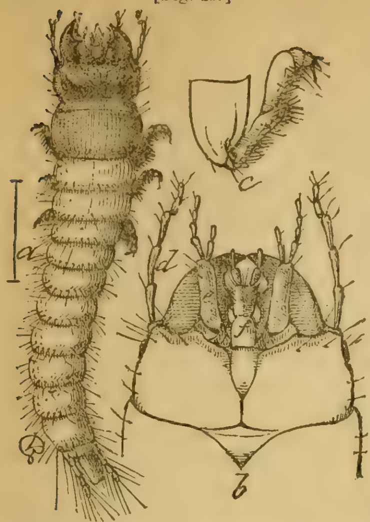
I think the silky mite has done good service in destroying eggs in one or two counties, particularly Noble. But we are getting, in addition, continual newspaper reports of white grubs destroying the eggs. I started out to see for myself, and have found a number which I send you.—[From A. Whitman, St. Paul, Minn., September 7, 1876.

This grub is found of various sizes as Winter sets in, and hibernates without change. It will doubtless be reared to the perfect state the coming Summer, and I give a more detailed description herewith.

Average length 0.50 inch. Body curved, glabrous, tapering posteriorly, swollen anteriorly. Color opaque whitish, with translucent yellowish mottlings and some vinous marks at sutures, especially along medio-dorsum. Sutures deep. A lateral row of swellings. Head small, flattened, dark-brown, in five pieces, consisting above of a frontal ovoid piece and two lateral pieces of somewhat similar form, and each bearing near tip a minute, 2-jointed palpus; beneath of two broad, sub-triangular jaws having forward and lateral motion, and each also bearing near the center, in a depression, a 2-jointed feeler. A spiracle each side in a fold between joints 2 and 3, and another on each side of the penultimate joint, 12. None otherwise perceptible.

Besides the three preceding species which have been found destroying the eggs the past year, and which, from their being generally

[Fig. 25.]



HARPALUS ? LARVA THAT PREYS ON LOCUST EGGS:—*a*, larva, from above; *b*, head, from beneath; *c*, leg—enlarged.

found within the egg-pod, may be called parasitic, though they are not strictly so; I have also found the larvæ of two species of Ground-beetles (*Carabidæ*) attacking said eggs. One pale species, (Fig. 25) evidently belonging to the genus *Harpalus*, is more particularly common and busy in the good work. It is an active creature, something over half an inch long, with powerful jaws and a light brown head and prothorax, and the rest of the body pale, tapering posteriorly and ending in a stout proleg and two articulate appendages. For the entomological reader I append a more detailed description:

Color yellowish white; prothorax and head highly polished yellowish-brown, the jaws darker. Head broad, depressed and rugose in front; jaws broad, robust, dark, and with but one strong middle tooth; antennæ 5-jointed, joints 4 and 5 scarcely equaling 3 in length; maxillæ elongate, subcylindrical, with a 4-jointed outer and a 2-jointed inner palpus; mentum elongate, its base soldered with the lower head; labrum also elongate and with 2-jointed palpi; all trophi armed with stiff hair. Prothoracic joint, swollen, wider than head, twice as long as succeeding joint, horny, and with a darker anterior border, limited by a transverse stria posteriorly and marked with fine longitudinal striæ. Legs, except coxæ, dark brown and thickly beset with short, spinous bristles of the same color. Abdomen tapering to end, with no horny plates, but each joint with two transverse rows of stiff yellowish hairs, the posterior rows strongest. Anal proleg stout, the cerci 4-jointed (joints 3 and 4 small and imperfectly separated) and reaching but little beyond it; eyes small, dark and just behind base of antennæ. Length of largest specimens 0.58 inch.

Eight specimens feeding on eggs of *Caloptenus spretus*.

The other Ground-beetle, belonging probably to the same genus as the above, is of about the same size and has precisely the same structure. It is at once distinguished, however, by a series of broad, dark-brown, horny plates along the back, by paler horny pieces along the sides and beneath; by the darker, somewhat narrower prothorax; by the pale legs, and by the shorter anal cerci. I have found three specimens of this last feeding on the eggs, and one was sent to me as having the same habit, by Mr. Whitman, of St. Paul. Mr. G. F. Gaumer has sent me what he took to be a minute Rove-beetle

[Fig. 26.]

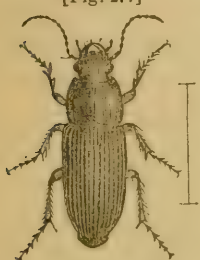
HARPALUS ? LARVA:—*B*, under-side of head; *h*, *i*, *j*, under-side of different joints of body.

(*Staphilinidæ*) found feeding on the eggs, and they prove to be newly hatched specimens of the above *Harpalus* larva.

It is probable that most of the Carabid larvæ will feed on the eggs, and I introduce the figure of a larger species (Fig. 26) and its probable parent, the Pennsylvania Ground-beetle (*Harpalus pennsylvanicus* De Geer, Fig. 27).

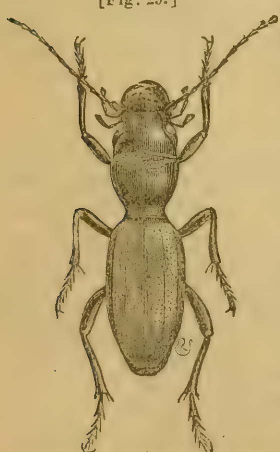
Insects which destroy the active Locust.—In addition to the many animals enumerated in previous reports, which destroy this locust, the Box-turtle may be mentioned, and Mr. Gaumer has found a large burrowing spider (doubtless a *Lycosa* or *Mygale*) to feed upon it. He has also examined several specimens infested with hair-worms, one of which was 18½ inches long. I have myself taken a specimen 6½ inches long, which proves, upon comparison, to be our commonest species, *Gordius aquaticus*. Mr. H. A. Brous, who, while in Western Kansas last Summer, made careful notes of everything he observed relating to the Rocky Mountain Locust, has sent me a number of insects found preying upon it that had not before been observed at such work. Among them are various Asilus-flies*, and several Ground-beetles and Tiger-beetles.† More particulary noteworthy among these last is that large and most elegant dark-brown species which I herewith figure (Fig. 29), and which has been esteemed as a great rarity among Coleopterists. Mr. Brous found it much more common than it was generally supposed, and attributes its reputed rarity to its secretive and nocturnal habits. It lives in holes in clayey banks, and issues in search of food only at night or early morn. Of Heteroptera, there is a Soldier-bug of the genus *Apiomerus* and allied to *crassipes*; and of Hymenoptera there are two Ichneumons—a *Compoplex* and *Ephialtes notanda* Cress—that were noticed pursuing the locusts, and are possibly parasitic upon them. The Preying Mantis (*Mantis Carolina*, Rep. 1, p. 169) has been also ob-

[Fig. 27.]



PENNSYLVANIA GROUND-BEETLE.

[Fig. 29.]



AMBLYCHILA CYLINDRIFORMIS.

[Fig. 28.]

ERAX BASTARDII.

* *Stenopogon consanguineus* Loew., a species with pale yellowish hairs on head and thorax, yellowish-brown wings and pale rufous legs and abdomen; *Promachus apivora* Fitch; *Erax Bastardii*; several allied species of *Erax*, and a species of *Tolmerus*.

† *Pasimachus elongatus* Lec.; *P. punctulatus* Hald.; *Calosoma obsoletum* Say; *Cicindela pulchra* Say; *C. scutellaris* Say; *C. 6-guttata* Fabr.; *C. fulgida* Say; *C. vulgaris* Say; *C. circumpicta* Laf.; *C. formosa* Say; *C. punctulata* Fabr.

served feeding on the locusts by Mr. H. S. King in Texas and by Mr. Brous in Kansas.

EXPERIMENTS WITH THE EGGS, AND CONCLUSIONS DRAWN THEREFROM.

There are many questions respecting the manner in which the eggs of this locust are affected under different conditions, which are of intense practical interest, and which are frequently discussed with no definite result being arrived at, or no positive conclusion drawn. Such are, for instance, the influence of temperature, moisture and dryness upon them; the effects of exposing them to the air, of breaking open the pods, of harrowing or plowing them under at different depths, of tramping upon them. Everything, in short, that may tend to destroy them or prevent the young locusts hatching, is of vital importance. With a view of settling some of these questions, and in the hope of reaching conclusions that might prove valuable, I have carried on, during the past Winter, a series of experiments, some of which are herewith summed up. By reference to the meteorological table given further on, in considering the "Condition of the Eggs," the exact temperature at any of the dates mentioned can be ascertained.

Experiments to test the Effects of alternately Freezing and Thawing.

The eggs in the following series of experiments were obtained early in November, at Manhattan, Kans., under similar conditions. They were mostly in a fluid state at the time, and none but good and perfect masses were used. They were all carefully placed in the normal position at the surface of the ground, in boxes that could be easily removed from place to place. The experiments commenced November 10th, 1876, and ended March 10th, 1877. During November and December the weather was severe, while during January and February it was largely mild and genial for the season. In March again there was much frost.

The temperature in my office, into which all the eggs when not exposed were brought, ranged during the day from 65° to 70° F., rarely reaching to 75°. During the night it never dropped below 40°, and averaged about 55°.

Experiment 1.—Fifty egg-masses were exposed to frost from November 10th to January 10th, and then taken in-doors. In 20 days they commenced hatching, and continued to do so for 38 days thereafter.

Experiment 2.—Fifty egg-masses exposed at the same time to frost. Brought indoors on December 10th. On December 31st they commenced hatching numerously

and continued to hatch till the 10th of January, 1877, when the remainder were exposed again. The weather being subsequently mild, some hatched on each warm day until the 26th. None hatched thereafter, and upon examination, subsequently, all were found to have hatched.

Experiment 3.—Fifty egg-masses exposed at same time. Brought in-doors December 1st. Kept there till the 22d without any of them hatching. Exposed again for three weeks, and then brought in-doors on the 12th of January. They commenced hatching two days thereafter, and continued till the 29th. Subsequent examination showed them all to have hatched.

Experiment 4.—One hundred egg-pods exposed at the same time, but alternately brought in-doors and exposed again every 14 days. Some commenced hatching during the second term in-doors; others continued during the warm days of the third exposure, and all had hatched by the sixth day of the third term in-doors.

Experiment 5.—A lot of 100 egg-masses alternately exposed and brought in-doors every week. During the first four terms of exposure they were continuously frozen, while during the next four the weather was frequently mild enough to permit hatching. They first began to hatch during the fourth term in-doors, and continued to hatch, except during the colder days when exposed, until the seventh term in-doors, during which the last ones escaped.

Experiment 6.—Many hundred egg-masses kept out-doors the whole time, first commenced hatching March 2d.

Experiment 7.—Many hundred pods, kept in-doors till December 15, and hatching from November 28th up to that time, were then exposed, and have continned to hatch whenever the weather permitted, and continue to hatch up to the present time (March 10.)

Experiment 8.—A lot of 100 pods that had been hatching in-doors from November 19th, were exposed to frost January 15th, and brought in-doors again January 28th, where they continued hatching till February 10th. Every one was subsequently found to have hatched,

Experiment 9.—A lot of 100 under same conditions as in experiment 8, up to January 28th. They were then exposed again and brought in-doors February 16th, when they commenced hatching and continued to do so till the 27th. All were found subsequently to have hatched.

Two important conclusions are deducible from the above experiment:

First—The eggs are far less susceptible to alternate freezing and thawing than most of us, from analogy, have been inclined to believe. Those who have paid attention to the subject, know full well that the large proportion of insects that hibernate on or in the ground, are more injuriously affected by a mild, alternately freezing and thawing Winter, than by a steadily cold and severe one; and the idea has quite generally prevailed, that it was the same with regard to our locust eggs. But, if so, then it is more owing to the mechanical action which, by alternate expansion and contraction of the soil, heaves the

pods and exposes them, than to the effects of the varying temperatures.

Second—That suspended development by frost may continue with impunity for varying periods, after the embryon is fully formed and the young insect is on the verge of hatching. Many persons, having in mind the well known fact that birds' eggs become addled if incubation ceases before completion, when once commenced, would, from analogy, come to the same conclusion with regard to the locust eggs. But analogy here is an unsafe guide. The eggs of insects hibernate in all stages of embryonic development, and many of them with the larva fully formed and complete within. The advanced development of the locust embryo, frequently noticed in the Fall, argues nothing but very early hatching as soon as Spring opens. Their vitality is unimpaired by frost.

Experiments to test the Influence of Moisture upon the Eggs.

The following series of experiments were made with eggs also brought from Manhattan, Kansas. They were dug up in December, and were sound, and much in the same condition as those in the preceding series.

The water in all but the last three, or experiments 23, 24 and 25, was kept in my office at the temperature already stated, and only changed when there was the least tendency to become foul. In the alternate submergence and draining, the eggs were submitted to the most severe hygrometric changes; the warm atmosphere of the room having great drying power.

Experiment 10.—Ten egg-masses kept under water in-doors from December 5th to December 26th, 1876, the water becoming quite foul. They were then removed to earth and kept in a hatching temperature. They commenced hatching January 11th, 1877, and continued to do so till February 5th—all having hatched.

Experiment 11.—Twenty egg-masses kept under water in-doors from December 26th, 1876, till January 2d, 1877; then left dry till the 9th; then submerged again till the 16th, when they were drained again. On the 20th, 18 young hatched, and others continued hatching till the 23d, when they were submerged again. From the 26th to 30th, a few hatched under water, successfully getting rid of the post-natal pellicle, and living for some hours afterward in the water. On the 30th day they were drained again, and continued to hatch. On February 6th, they were again immersed, and continued to hatch on the 7th. On the 15th, 22d, 29th, and March 7th, they were alternately drained and immersed; but none hatched after February 7th, and the remainder proved upon examination to have been destroyed, most of them being quite rotten.

Experiment 12.—Two egg-masses taken from the lot in Experiment 11, on February 7th, and placed in moist earth. Every egg subsequently hatched.

Experiment 13.—Two egg-masses taken from the lot in Experiment 11, on February 22d, and placed in moist earth. All hatched.

Experiment 14.—Twenty egg-masses alternately immersed and drained every two

weeks from December 26th till March 6th. None hatched, but three-fourths of the eggs were at this date sound, the embryon full-formed and active as soon as released, but pale, and evidently too feeble to burst the egg-shell. The rest were killed and more or less decomposed.

Experiment 15.—Two egg-masses, after immersion for two weeks, were placed in moist earth. They began hatching 22 days afterward, and continued to do so for 6 days. It was subsequently found that only seven out of forty-eight eggs had collapsed and failed to hatch.

Experiment 16.—Two egg-masses immersed for two weeks, and drained for two weeks; then placed in moist earth. Six days afterward they commenced hatching, and continued to do so for 2 days. Subsequently examined, 28 out of 54 eggs had perished.

Experiment 17.—Two egg-masses alternately immersed, drained, and immersed again every two weeks, were placed in moist earth. They commenced hatching two days afterward, and continued to do so for 12 days. Upon subsequent examination, 23 out of 52 had perished.

Experiment 18.—Twenty egg-masses immersed from Dec. 26, 1876, to Jan. 16, 1877; then drained till Feb. 6th, then immersed till Feb. 27th, then drained again. On Feb. 3d, while dry, they commenced hatching numerously, and a few continued for two days to hatch while immersed. An examination March 7th, showed about half of them still alive, the rest rotten.

Experiment 19.—Twenty egg-masses immersed from Dec. 26, 1876, to Jan. 23, 1877; then drained till Feb. 20th, then submerged again. They commenced hatching on the 6th of Feb., and continued two days after the second submergence. On the 7th of March but about 5 per cent. had rotted.

Experiment 20.—Two egg-masses immersed for 4 weeks; then drained for 2 weeks; then immersed for one week; then placed in moist earth. They commenced hatching 7 days afterward, and continued to do so for 6 days. Subsequently examined, one of the masses was rotten; the eggs in the other had all hatched.

Experiment 21.—Twenty egg-masses kept from Dec. 26th, 1876, in earth saturated with moisture. On Feb. 23d, 1877, they commenced hatching, and continued to do so till March 7th, when all were found to have hatched, except one pod, which was rotten.

Experiment 22.—Twenty egg-masses, alternately placed every five days, from Dec. 26, 1876, in earth saturated with moisture and in earth which was very dry. Commenced hatching Feb. 14th, and continued till March 7th, when, upon examination, 9 of the pods were found rotten.

Experiment 23.—Twenty egg-masses immersed and exposed out-doors Dec. 26, 1876. From that time till March 7th, the water was frozen and completely thawed at 6 different times, the vessel containing them, which was of glass and admitted the sunlight, several times breaking. The changes were as follows: Frozen till Jan. 10th; then thawed till the 12th; then frozen till the 18th; then thawed till the 20th; then frozen till the 26th; then thawed till Feb. 20th; then partly frozen till the 22d; then thawed till the 26th; then frozen till the 27th; then thawed till March 5th; then frozen. Examined on the 7th of March, one pod only was found rotten; the others apparently sound.

Experiment 24.—Two egg-masses under same conditions as in Expt. 23, till Feb. 9th, when they were brought in-doors and placed in earth. One was dried up on the 16th; the other commenced hatching on the 27th, and when examined on March 7th, all the eggs in it were found to have hatched.

Experiment 25.—Two egg-masses under same conditions as in Expt. 23, till Feb. 27th, when they were placed in earth in-doors. Those examined March 7th were sound, and near the hatching point.

These experiments, though not yet completed at the time this MS. goes to the printer, yet establish a few facts that were somewhat unexpected. The insect is a denizen of the high and arid regions of the Northwest, and has often been observed to prefer dry and sunny places, and to avoid wet land, for purposes of ovipositing. The belief that moisture was prejudicial to the eggs, has, for these reasons, very generally prevailed. The power which they exhibit of retaining vitality, and of hatching under water or in saturated ground, is, therefore, very remarkable—the more so when viewed in connection with the results obtained in the succeeding experiment. That the eggs should hatch after several weeks submergence, and that the young insect should even throw off the post-natal pellicle, was, to me, quite a surprise, and argues a most wonderful toughness and tenacity. After being dried and soaked for over six weeks, under conditions that approach to those of Spring, I found a good proportion of the eggs to contain the full-formed and living young, which, though somewhat shrunken, and evidently too weak to have made its exit, was still capable of motion. The water evidently retards hatching. An examination of the submerged eggs that remained unhatched long after others had hatched, which had been under similar treatment up to a certain time, and then transferred to earth, showed the jaws and tibial spines to be still quite soft. It is, therefore, in preventing the proper hardening of these delivering points, that water doubtless retards the hatching, and prevents its accomplishment long before the embryon perishes. Yet, when once life has gone, the egg would seem to rot quicker in the water than in the ground.

The results of Experiments 23—25 prove conclusively that water in Winter time, when subject to be frozen, is still less injurious to the eggs.

Altogether, these experiments give us very little encouragement as to the use of water as a destructive agent; and we can readily understand how eggs may hatch out, as they have been known to do, in marshy soil, or soil too wet for the plow; or even from the bottom of ponds that were overflowed during the Winter and Spring. While a certain proportion of the eggs may be destroyed by alternately soaking and drying the soil at short-repeated intervals, it is next to impossible to do this in practice during the Winter season as effectually as it was done in the experiments; and the only case in which water can be profitably used is where the land can be flooded for a few days just at the period when the bulk of the eggs are hatching.

Experiments to test the Effects of Exposure to the Free Air.

The eggs in the following series were obtained at Manhattan, Kansas, in November, and all under similar conditions.

Experiment 26.—A large number of egg-masses were thoroughly broken up and the single eggs scattered over the surface of the ground out-doors early in December. By the 23d of February all had perished, and most of them had collapsed and shriveled.

Experiment 27.—A large number of pods were partly broken up and exposed as in Exp. 26. On the 10th of March the outer eggs were mostly dead and shrunken, but a few of the protected ones were yet plump, the embryon well advanced and apparently sound.

Experiment 28.—A large number of unbroken pods were exposed under similar conditions as in the preceding Expts. By March 10th fully three-fourths of the eggs had perished.

Experiment 29.—Fifty egg-masses were kept in-doors in an open mouthed bottle in perfectly loose and dry earth from November 6th. Fully 8 per cent. of the eggs had hatched by December 28th, when hatching ceased, and a subsequent examination showed the rest to have shrunken and perished.

It is very evident from the above experiments that we can do much more to destroy the eggs by bringing into requisition the universally utilizable air, than we can by the use of water. The breaking up of the mass and exposure of the individual eggs to the desicating effects of the atmosphere, effectually destroys them; and when to this is added the well known fact that thus exposed they are more liable to destruction by their numerous enemies, we see at once the importance of this mode of coping with the evil.

Experiments to test the Effects of burying at different Depths, and of pressing the Soil.

The following series of experiments were made with eggs obtained at Manhattan, Kansas, early in November, and which were in similar condition to those in the first series. Large tin cylindrical boxes, made of different depths, and varying from 4 to 8 inches in diameter were used; and in order to hasten the result they were kept in-doors at the temperature already mentioned. The soil in all the boxes was finely comminuted and kept in uniform and moderately moist condition. It was gently pressed with the fingers, so as to approach in compactness the surface soil of a well cultivated garden. In each instance the eggs were placed in the centre of the box. A large number of eggs have been buried at different depths out-doors where they are under natural conditions of soil pressure and temperature, and the experiments here recorded were made to anticipate the results in the others, which will not be completed till long after this Report is published.

Experiment 30.—Ten egg-masses were placed just one inch below the surface in the centre of a box 4 inches in diameter. The young began to appear January 30th, when it was noticed that every one came up at the side of the box, between the earth and the tin, where there was more or less shrinking of the former from the latter. Upon pressing the earth more firmly around the border, the issuing of the young ceased. Upon examining the eggs March 7th, it was found that they had all hatched. A few of the young were still alive and endeavoring to escape. The rest had died in the effort. They had made no progress upward through the pressed surface, but had pushed horizontally as the looser earth permitted.

Experiment 31.—From 10 egg-masses placed 2 inches beneath the surface the young commenced issuing from the sides as in the preceding Exp., Jan. 31st. None issued directly through the surface of the soil, and none issued after the border was pressed more firmly to the tin. Subsequent examination showed the soil penetrated in devious directions, but none of the insects had reached higher than within $\frac{3}{4}$ inch of the surface.

Experiment 32.—Ten egg-masses placed 3 inches below the surface. The young began, Jan. 31st, to issue from the sides as in Expts. 30, 31. Upon pressing the ground more firmly around the borders, none afterward issued, and subsequent examination showed that the young had tunneled the earth in tortuous passages toward the sides, and perished there; without reaching nearer than within an inch of the surface in the middle of the box.

Experiment 33.—Ten egg-masses placed 6 inches below the surface. On Feb. 1st the young commenced to issue, as in the preceding Expts., from the side, and continued to do so till the 4th, when the earth was pressed more closely to the tin. None issued afterward. Subsequent examination showed that some had succeeded in working their way upward through the soil to within two inches of the surface; but most had reached the sides and there collected and perished between the tin and the soil.

Other experiments, made in glass tubes where the movements of the insects could be watched, all produced similar results to those above given, and all point to the conclusion that where the newly hatched insect has not the natural channel of exit (described on p. 88) which was prepared by the mother, it must inevitably perish if the soil be moderately compact, unless cracks, fissures, or other channels reaching to the surface, are at hand.

From the above four series of experiments, I would draw the following deductions, which have important practical bearing:

First—Frost has no injurious effect on the eggs; its influence is beneficial rather, in weakening the outer shell.

Second—Alternately freezing and thawing is far less injurious to them than we have hitherto supposed, and tends to their destruction, if at all, indirectly, by exposing them to the free air.

Third—The breaking open of the egg-masses, and exposure of the eggs to the atmosphere, is the most effectual way of destroying them. Hence, the importance of harrowing in the Fall is obvious.

Fourth—Moisture has altogether less effect on the vitality of the eggs than has heretofore been supposed, and will be of little use as a

destructive agent, except where land can be overflowed for two or three days at the time when the bulk of the young are hatching.

Fifth—Plowing under of the eggs will be effectual in destroying them, just in proportion as the ground is afterward harrowed and rolled. Its effects will also necessarily vary with the nature of the soil. Other things being equal, Fall plowing will have the advantage over Spring plowing, not only in retarding the hatching period, but in permitting the settling and compacting of the soil; while where the ground is afterwards harrowed and rolled, the Spring plowing will prove just as good, and on light soils, perhaps better.

THE OMAHA CONFERENCE.

At the invitation of Governor Jno. S. Pillsbury, of Minnesota, a conference of the Executives of those States and Territories which most suffer from locust ravages, and of scientific gentlemen interested in the subject, was held at Omaha, Neb., on the 25th and 26th of October last. The following gentlemen were in attendance:

Prof. Cyrus Thomas, of Illinois.
Gov. Samuel J. Kirkwood, of Iowa.
Gov. Thomas A. Osborne, of Kansas.
Gov. Silas Garber,
Ex-Gov. Robt. W. Furnas,
Prof. C. D. Wilber,
Prof. A. D. Williams, and
Hon. Geo. W. Frost, of Nebraska.
Gov. John S. Pillsbury,
Pennock Pusey, and
Prof. A. Whitman, of Minnesota.
Gov. John L. Pennington, of Dakota, and
Gov. C. H. Hardin, and
C. V. Riley, of Missouri.

After an interesting and instructive interchange of opinions and experiences, the following resolutions, reported by the writer on behalf of a committee appointed to express the sense of the Conference, were unanimously adopted:

Your Committee, appointed to draft resolutions expressive of the views of the Conference, would respectfully report as follows:

The Rocky Mountain Locust, or "grasshopper," by its migrations from Territory to Territory and from State to State, destroying millions of dollars' worth of the hard earnings of the Western farmers, crippling the progress of the border States, and retarding the settlement of the Territories, has become a national plague. Its injuries are of such magnitude that no effort should be left untried that will be likely to diminish or avert them.

The work to be done is of a two-fold nature—State and National. From the writings of those who have given the subject careful attention, and from our own past experience, it is quite manifest that the pest in question is not a native of the country

south of the 44th parallel or east of the 100th meridian, but that it occasionally overruns the country south and east of these lines, from the extreme Northwest.

There are, therefore, two pressing questions which demand our attention:

1st The best means of fighting the plague as it occurs in the States to which it migrates, but in which it is not indigenous.

2d. The thorough investigation into its habits in its native home, with a view of preventing, if possible, its migrations therefrom.

Toward the elucidation and settlement of the first we have the dear-bought experience of the past few years, and there has already been a large amount of valuable information obtained and published in the proclamation of Gov. Pillsbury, in the report of the special Minnesota commission, appointed in 1875, in the two last entomological reports made to the State of Missouri, by its State entomologist, and in the writings of Prof. Thomas and others. We, therefore, recommend the passage of the following resolutions:

Resolved, That, as much valuable and practical advice has already been published a committee of three be appointed to collect and issue in pamphlet form, as soon as possible, all the more practicable means, based on experience, that we now have any knowledge of, toward the destruction of the insect, whether as it pours down upon us in the winged condition, or as it hatches out in our midst.

Resolved, That the official report of the proceedings of this Conference shall form the prelude to this pamphlet, and that the following recommendations and statement of our views, as to the possibility of contending with the locust shall form a part of said pamphlet. [Here omitted.]

Further, in order to meet the emergency that threatens next Spring, particular stress should be laid on the best means of coping with the eggs and unfledged young that will hatch from them in the Spring of 1877. Among these, we deem as most feasible and best calculated to produce good results, a judicious bounty system; and, as that recommended by Prof. Riley, in his eighth report, is based on the valuable experience gained in 1875, and correctly states the principles that should govern such legislation, we recommend the following:

Resolved, That in our opinion it will be wise and politic for the legislatures of each of the States and Territories most deeply interested in the locust question, to enact a State bounty law, offering a bounty of——per bushel for the collection and destruction of the eggs, and of——per bushel for the destruction of the unfledged insects; that the principles laid down by Prof. Riley for such a law should be kept in view; and that we will use our influence to obtain such a law in our respective States.

Resolved, That we recommend to the several legislatures, that they authorize local taxation for the purpose of systematized effort in the way of ditching, burning, etc., as the local authorities may deem necessary or desirable.

We further invoke our legislatures to adopt such practicable measures as have proved efficacious, and such as further experience may suggest, including the repeal of existing game laws, or such modification of them as will prevent the destruction of birds which feed upon the insects; the prevention of prairie fires until suitable time for the destruction of the young locusts by firing the grass; the encouragement of tree culture for promoting moisture and harboring birds, and such other means as may promote the great end desired.

Resolved, further, That in view of the danger that threatens, it is advisable that, as far as posible, a survey be made of each State during the coming Winter, to ascertain just those portions of each county in which the eggs are most thickly laid, in order to indicate to the county and State authorities the amount of the preparatory work to be done to prevent the threatened injury, and also in order to more thoroughly organize every portion of each State on some plan of securing the intelligent co-operation of farmers and others.

We also recommend the passage of the following resolution:

Resolved, That the Governors of each State and Territory be advised to appoint a commission of one or more competent persons whose duties shall be to visit the counties and towns of each State, and report the facts and observations to the Governors, and also to organize each county and precinct in such manner as may be deemed expedient, and also to appoint in said counties and precincts, suitable persons to receive and distribute such documents and pamphlets, containing general information and means of defence, as will be provided by this Conference, and to report such organizations and names of committees to the respective Governors.

For the solution of the second question, it is the evident duty of the Government to make the proper investigation. We have looked in vain for this aid from our Department of Agriculture, and are satisfied that under its present management, such aid, or any thorough investigations, are not to be expected. We therefore recommend the following:

Resolved, That we deem it the duty of the National Government to make some effort to destroy or counteract this great pest, and thus prevent its injuries.

Resolved, That we believe the first step in this matter should be a thorough investigation into the history and habits of this insect, in its native haunts as well as in the sections visited by it, and the search for all possible means of its extermination, and remedial agencies which may be used against it.

Resolved, That we believe this can be accomplished in the shortest time, at the least expense and most effectually by attaching a special commission for this purpose, to one of the Government Surveys sent out annually to the West; and, therefore, we suggest that the following be added to that clause of the Sundry Civil Appropriation Bill, making an appropriation for the geological and geographical survey of the Territories: "And also the further sum of twenty-five thousand dollars for the purpose of paying the salaries and expenses of a commission to consist of three entomologists and two Western men who have had experience with the locusts, to be appointed by the Chief of said survey, with the consent and approval of the Secretary of the Interior. It shall be the duty of said commissioners to examine into the history and habits of the said locust, and make report thereon, and also suggest such means of destroying them or remedies against them as their investigations shall prove most practicable."

Resolved, That it is our belief that the Signal Service might materially aid such a commission as here demanded, in performing the work, by regular observations made of the time, direction, extent of flights, time of hatching and leaving of the young locusts, etc.; also, by announcing in the daily weather reports the appearance and progress of the swarms; and we ask of Congress to grant to Gen. Myer such additional assistance and means as will enable him to carry out this work.

Resolved, That the President of the Conference be requested to draw up and present to the President of the United States, a letter setting forth the urgent necessity for some action on the part of the General Government in behalf of the sections ravaged, in reference to the invasions of and destruction occasioned by the locusts.

Resolved, That each of the Governors of the following States and Territories, to-wit: Minnesota, Illinois, Iowa, Kansas, Nebraska, Missouri, Colorado, Wyoming, Dakota and Montana, be requested to transmit to their respective delegations a record of these proceedings, requesting them to urge upon Congress speedy action in this matter, in accordance with the recommendations of this Conference.

A committee consisting of John S. Pillsbury, Pennock Pusey, and myself, was appointed to prepare for publication the official report of Proceedings, together with a summary of the best means known for counteracting the evil; and 10,000 copies of a pamphlet of 72 pages were accordingly published last Fall. By being widely distributed, this pamphlet has undoubtedly done much good, and had no small share in bringing about certain much needed State and National legislation.

REMEDIES AND SUGGESTIONS.

As the people in the threatened counties already enumerated (*ante*, p. 67) will, in all probability, go through much the same experience this year, that the farmers of the afflicted counties went through in 1875, there will be a large demand for information as to how best to manage and destroy the young insects. In the hope that this Report will be distributed at an early day, I have thought best to repeat here some of the recommendations made in my last Report, and in the Omaha pamphlet.

Destruction of the Young or unfledged Locusts. — Heavy rolling, where the surface of the soil is sufficiently firm and even, destroys a large number of these

newly hatched young, but is most advantageously employed when they are most sluggish and inclined to huddle together, as during the first eight or ten days after hatching, and in the mornings and evenings subsequently. They then drive almost as readily as sheep, and may be burned in large quantities by being driven into windrows or piles of burning hay or straw. They may also be killed with kerosene, and by means of flattened beating implements; wooden shovels being extensively used for this purpose in Europe.

But to protect the crops and do battle to these young locust armies, especially where, as was the case in much of the ravaged country in 1875, there is little or no hay or straw to burn, the best method is ditching. A ditch two feet wide and two feet deep, with perpendicular sides, offers an effectual barrier to the young insects. They tumble into it and accumulate, and die at the bottom in large quantities. In a few days the stench becomes great, and necessitates the covering up of the mass. In order to keep the main ditch open, therefore, it is best to dig pits or deeper side ditches at short intervals, into which the 'hoppers will accumulate and may be buried. Made around a field about hatching time, few 'hoppers will get into that field till they acquire wings, and by that time the principal danger is over, and the insects are fast disappearing. If any should hatch within the enclosure, they are easily driven into the ditches dug in different parts of the field. The direction of the apprehended approach of the insects being known from their hatching locality, ditching one or two sides next to such locality, is generally sufficient, and where farmers joint hey can construct a long ditch, which will protect many farms.

With proper and systematic ditching early in the season, when the insects first hatch, everything can be saved. When water can be let into the ditches so as to cover the bottom they may be made shallower, and still be effective.

A ditch three feet wide, unless correspondingly deep, will be more apt to permit the escape of the insects, when once in, than a narrower one. In hopping, the more perpendicular the direction the insects must take, the shorter will be the distance reached. Of course the wider the ditch, if it be correspondingly deep, the more effectual will it prove. In exceptional cases, when the locusts are nearly full grown and the wind is high so as to assist them, even the two-foot ditch loses much of its value.

Next to ditching the use of nets or seines, or converging strips of calico or any other material, made after the plan of a quail net, has proved most satisfactory. By digging a pit, or boring a post auger hole, three or four feet deep, and then staking the two wings so that they converge toward it, large numbers of the locusts may be driven into the pit after the dew is off the ground. By changing the position of this trap, much good can be done when the insects are yet small and huddled in schools; but all modes of bagging, netting, crushing with the spade or other flat implements and burning, which can be employed to good advantage when the insects first begin to hatch, become comparatively useless when they begin to travel in concert over wide stretches of land. The same may be said of all the mechanical contrivances to facilitate the destruction of the insects; they are useful if used in concert in a given neighborhood soon after the young hatch, but subsequently do not compare to ditching.

When the insects are famishing, it is useless to try and protect plants by any application whatever, though spraying them with a mixture of kerosene and warm water is the best protection yet known, and will measurably answer when the insects are not too numerous or ravenous.

The best means of protecting fruit and shade trees deserves separate consideration. Where the trunk is smooth and perpendicular, they may be protected by whitewashing.

The lime crumbles under the feet of the insects as they attempt to climb, and prevents their getting up. By their persistent efforts, however, they gradually tear off the lime and reach a higher point each day, so that the whitewashing must be often repeated. Trees with short, rough trunks, or which lean, are not very well protected in this way. A strip of smooth, bright tin answers even better for the same purpose. A strip three or four inches wide brought around and tacked to a smooth tree will protect it; while on rougher trees a piece of old rope may first be tacked around the tree and the tin tacked to it, so as to leave a portion both above and below. Passages between the tin and rope or the rope and tree can then be blocked by filling the upper area between tin and tree with earth. The tin must be high enough from the ground to prevent the 'hoppers from jumping from the latter beyond it; and the trunk below the tin, where the insects collect, should be covered with some greasy or poisonous substances to prevent girdling. This is more especially necessary with small trees; and kerosene or whitewash having Paris green mixed with it will answer as such preventives.

One of the cheapest and simplest modes is to encircle the tree with cotton batting, into which the insects will entangle their feet, and thus be more or less obstructed. Strips of paper covered with tar, stiff paper tied on so as to slope roof-fashion, strips of glazed wall paper, thick coatings of soft soap, have been used with varying success; but no estoppel equals the bright tin; the others require constant watching and renewal, and in all cases coming under my observation some insects would get into the trees so as to require the daily shaking of these morning and evening. This will sometimes have to be done when the bulk of the insects have become fledged, even where tin is used; for a certain proportion of the insects will then fly into the trees. They do most damage during the night, and care should be had that the trees be unloaded of their voracious freight just before dark.

Finally, most cultivated plants may be measurably protected from the ravages of these young by good cultivation and a constant stirring of the soil. The young have an antipathy to a loose and friable surface, which incommodes them and hinders their progress; and they will often leave such a surface for one more hard and firm.

Hogs and poultry of every description delight to feed on the young locusts, and will flourish where these abound when nothing else does. Our farmers in the threatened counties should provide themselves with as large a quantity as possible of this stock. Where no general and systematic efforts have been made to destroy either the eggs or the young locusts, and it is found that, as Spring opens, these young hatch out in threatening numbers, the intelligent farmer will delay the planting of everything that cannot be protected by ditching until the very last moment, or till the insects become fledged—using his team and time solely in the preparation of his land In this way he will not only save his seed and the labor of planting, and, perhaps, replanting, but he will materially assist in weakening the devouring armies. Men planted in 1875, and worked with a will and energy born of necessity, only to see their crops finally taken, their seed gone, and their teams and themselves worn out. The locusts in the end destroyed every green thing, until finding nothing more, they began to fall upon each other and to perish. This critical period in their history would have been brought about much earlier if they had not had the cultivated crops to feed upon; and if by concert of action this system of non-planting could at first have been adopted over large areas, the insects would have been much sooner starved out and obliged to congregate in the pastures, prairies and timber. Moreover the time required for early planting and cultivation, if devoted to destroying the insects after the bulk of them hatch out toward the end of April, would virtually annihilate them.

Too much stress cannot be laid on the advantages of co-operation and concert of

action, to accomplish which ought not to be difficult, with our present Grange system. To insure concert of action, it would be well to authorize the supervisors of each school district to call out every able-bodied man and oblige him to work in a general system of destruction as soon as the bulk of the young insects have hatched, and the same would apply equally as well to the destruction of the eggs.

Many of the wheat fields have been injured principally on the outside. I would recommend to plow up such injured portions and sow to rye. Finally, though insisting on ditching and the digging of pits, as, all things considered, the best and most reliable insurance against the ravages of the young locusts; I would urge our farmers to rely not on this means alone, but to employ all the other means recommended, according as convenience and opportunity suggest.

LEGISLATION.

It is a gratifying indication of the increasing appreciation of economic entomology that, while three years ago the mere suggestion to enact laws for the suppression of injurious insects would have been, and was received by our legislators with ridicule; yet, during the Winter of 1876–7, several States have seen fit to pass acts that have for object the destruction of this locust, or the relief of the suffering and destitution it so often entails. Even Congress has at last felt the necessity of doing something to mitigate this national evil, and at the last hour, made an appropriation to defray the expenses of a commission, whose duty it shall be to make a thorough investigation into the matter. I give below the State laws that have been passed:

MISSOURI.—An act to encourage the destruction of grasshoppers.

Be it enacted by the General Assembly of the State of Missouri, as follows:

Section 1. Any person who shall gather, or cause to be gathered by any person in his employ, eggs of the Rocky Mountain locust or grasshopper, at any time after they are deposited in the earth in the autumn of any year, and before they are hatched the following spring, shall be entitled to a bounty of five dollars for each and every bushel of eggs thus gathered, or for any quantity less than one bushel, bounty at the same rate, to be paid, one-half by the State and one-half by the county in which they are gathered.

Sec. 2. Any person who shall gather, collect and kill, or cause to be so collected and killed, young and unfledged grasshoppers in the month of March, shall be entitled to a bounty of one dollar for each bushel, and for the month of April, fifty cents per bushel, and for the month of May, twenty-five cents per bushel, to be paid in the same manner as in the preceding section.

Sec. 3. Any person claiming bounty under this act, shall produce the eggs and grasshoppers thus gathered or killed, as the case may be, before the clerk of the county court in which such eggs or grasshoppers were gathered or killed, within ten days thereafter, whereupon said clerk shall administer to such person the following oath or affirmation: You do solemnly swear (or affirm, as the case may be,) that the eggs (or grasshoppers, as the case may be,) produced by you, were taken and gathered by you, or by person or persons in your employ, or under your control, and within this county and State.

Sec. 4. The clerk shall forthwith destroy said eggs by burning the same and give to the person proving up the same under his hand and seal, a certificate setting forth in a plain handwriting, without interlineation, the amount of eggs or grasshoppers pro-

duced and destroyed by him, and the name and residence of such person producing the same, which certificate shall be in the following form:

STATE OF MISSOURI, }
COUNTY OF.................. }

This is to certify that .... in the county of .... A. B., did this day prove before me that he had gathered, or caused to be gathered, ... of eggs, ... grasshoppers, and is entitled to the sum of .... dollars, and .... cents.

Given under my hand and seal of my office, this .... day of .... A. D. 18......

.... A. B., Clerk County Court.

Which certificate shall be received and taken by the collector of revenue of the county in which the same was given, and such collector shall be allowed pay out of the county and State Treasury, one-half from each.

SEC. 5. Such clerk shall keep a register of all such certificates given by him, in a book which he shall keep for that purpose, in which he shall note down every certificate granted by him, the number and amount, and to whom granted, and transmit a certified copy of such register, under the seal of the court, to the Treasurer of the State, who shall not allow and pay any certificate, which does not correspond with such register.

SEC. 6. Such clerk shall receive for his services as aforesaid, one dollar for such certified copy of the register, and the regular fee for the certificate and seal, and ten cents for each certificate granted under this act, all to be paid out of the treasury of his county.

SEC. 7. As the object of this act is the rapid destruction of the locust the ensuing spring, it shall take effect and be in force from and after its passage.

Approved February 23, 1877.

This act is drawn up after the form recommended in my last Report, and reprinted in the Omaha pamphlet. Section 3, requiring persons claiming bounty, to carry from all parts of the county, the eggs or young insects collected, is defective, as those living near the county seat will have most advantage and inducement. It would be better, as I suggested years ago, to empower the Township Trustee, or the Street Commissioner, to receive and measure the eggs or young insects, and to issue certificates setting forth the number of bushels destroyed—the certificates to be filed with the County Clerk. But even with this slight defect, the act will have a beneficial effect in the counties subject to locust ravages:

KANSAS—AN ACT TO PROVIDE FOR THE DESTRUCTION OF GRASSHOPPERS AND TO PUNISH FOR VIOLATION OF THIS ACT.

Be it enacted by the Legislature of the State of Kansas:

SECTION 1. That the township trustees of the different townships, and the mayors of cities which are not included in any township of any county within this State, are hereby authorized and it is made their duty, when so requested, in writing, by fifteen of the legal voters of the township or city, to issue orders to the road overseers of the different road districts within their respective townships or cities, to warn out all able bodied males between the ages of twelve and fifty years within their respective districts for the purpose of destroying locusts or migratory insects.

SEC. 2. It shall be the duty of road overseers, immediately after receiving said orders, to proceed at once to warn out all persons liable under section one of this act, giving notice of the time and place of meeting, and the tools to be used, and the kind of work expected to be performed, and all work shall be done and performed under the direction of the road overseers.

SEC. 3. Any persons over eighteen years of age warned out as is provided in this act, may pay the road overseer the sum of one dollar per day for the time so warned out, and in case any persons shall fail to perform labor under this act or paying the sum of one dollar when so warned out, shall be adjudged guilty of a misdemeanor, and on conviction, shall be fined the sum of three dollars for each day so failing or

refusing, and the moneys so collected shall be expended by the road overseer in the destruction of grasshoppers in their respective road districts.

SEC. 4. For the purpose of carrying out the provisions of this act the road overseer is authorized to enter upon the premises of any person lying within the township where such order of the township trustee is in force, with a sufficient number of hands and teams to perform such labor as he may deem necessary for the public good.

SEC. 5. It shall be the duty of the Secretary of the State Board of Agriculture, immediately after the passage of this act, to compile in circular form all information relating to the manner and means heretofore used for the extermination of grasshoppers, and send at least ten copies of the same to each township trustee in the State.

SEC. 6. This act shall take effect and be in force from and after its publication once in the Commonwealth.

Approved March 6, 1877.

AN ACT PROVIDING FOR A CONCERT OF ACTION BY SENATORIAL DISTRICTS FOR THE DESTRUCTION OF GRASSHOPPERS.

Be it enacted by the Legislature of the State of Kansas:

SECTION 1. That in any senatorial district in the State of Kansas, where trouble is anticipated from the ravages of young grasshoppers, in the year 1877, and any subsequent year thereafter, it shall be lawful for the counties in said senatorial district to co-operate together in the way and manner herein provided, for the destruction of the same.

SEC. 2. The chairman of the board of county commissioners in the county having the largest number of inhabitants in a senatorial district, where two or more counties form said district, may notify the chairman of each of the boards of county commissioners of the remaining counties in said district, of the time and place when the chairmen of the several boards of commissioners of the respective counties forming said senatorial district shall hold a joint meeting.

SEC. 3. At such meeting two of their number shall be chosen to act as chairman and secretary, and the proceedings of the meeting shall be published in all the newspapers printed in the senatorial district.

SEC. 4. Said meeting shall designate the manner of procedure by road overseers, and what day or days the young grasshoppers should be driven from the cultivated land on the unburnt prairie or places of destruction, and shall also designate on what day or days the grasshoppers shall be destroyed, by burning or otherwise, in said senatorial district, giving at least ten days' notice of the same by publishing in the newspapers of the said district.

SEC. 5. The board of commissioners of each county shall notify the road overseers of said county of the time fixed upon by the joint meeting for the driving and burning, or destroying by other means, of the grasshoppers in the district; said notice to be given to said overseers as soon as practicable after the same shall have been determined by the joint meeting.

SEC. 6. Said road overseer shall immediately notify the residents of his road district of the time designated and the manner of procedure, in order to carry out the provisions of this act. He shall also specify what tools or implements will be required of each resident in performing the labor required of him; and such notice may be enforced the same as in the acts authorizing road overseers to warn out the residents to perform road labor; and a refusal shall subject such persons refusing to the same penalties as are provided by law in such cases.

SEC. 7. The road overseers shall direct the manner of performing the labor, and have the supervision of the same, and shall keep a list of the names of those who shall perform labor, and shall certify the number of days' work performed by each, and shall place such certified list in the possession of the board of county commissioners of his county.

SEC. 8. It shall be lawful for two or more senatorial districts to co-operate together under the provisons of this act, on a basis of action which they may agree upon.

SEC. 9. This act shall take effect and be in force from and after its publication in the daily *Commonwealth.*

Approved March 7, 1877.

Both these acts look to compulsory work and concert of action, and in these respects are preferable to bounty acts, and will, without doubt, be productive of more good to the community at less expense to the State. The objects of the two acts should, I think, have been combined in one.

MINNESOTA.—AN ACT TO PROVIDE FOR THE DESTRUCTION OF GRASSHOPPERS AND THEIR EGGS.

Be it enacted by the Legislature of the State of Minnesota:

SECTION 1. There shall be paid by this State, out of any moneys in the treasury thereof, not otherwise appropriated, to any person or persons living within any of the counties in said State afflicted by grasshoppers, the following bounties for catching and destroying of the same, and the destruction of their eggs.

SEC. 2. The sum of one dollar per bushel for grasshoppers caught previous to the twenty-fifth day of May next. The sum of fifty cents per bushel from the said twenty-fifth day of May to the tenth day of June. The sum of twenty-five cents per bushel from the said tenth day of June to the first day of July, and twenty cents per bushel from the said first day of July to the first day of October next.

SEC. 3. There shall also be paid in the same manner, the sum of fifty cents per gallon for any and all grasshopper eggs taken and destroyed by any person or persons.

SEC. 4. There shall be appointed by the Governor a competent person in each township in the several counties so afflicted by grasshoppers, who shall be a resident of the township for which he shall be appointed, to receive, measure and destroy the grasshoppers and their eggs delivered to him by any person or persons catching and taking the same, which said person so appointed shall take and subscribe an oath for the faithful discharge of his duties, which oath, together with the certificate of appointment, shall be filed in the office of the county auditor, and he shall receive as compensation for his services such sum as the county commissioner may determine, to be paid out of the funds of the county, and in case of necessity, when he cannot perform the duties of his office, said measurer shall have authority and be empowered to appoint a suitable and competent person his assistant, which assistant shall be required to take and subscribe the same oath and be subject to the same penalties as the said measurer.

SEC. 5. The person receiving and measuring the grasshoppers and their eggs as aforesaid, shall measure and immediately and effectually destroy the same, and keep an exact account of all the grasshoppers and their eggs received by him and the names of the persons delivering the same, and shall issue a certificate for the amount of grasshoppers and their eggs to the person delivering the same. And he shall, at the end of each week after commencing to receive and measure the same, and on the second day of June, on the eleventh day of said month, on the second day of July, and on the second day of October next, make a report to the county auditor of all the grasshoppers and their eggs measured by him, the number of certificates issued, and the names of the persons to whom he issued the same; and the county auditor shall examine the same and file it in his office, which report shall be subject to public inspection; and the county auditor shall, at the end of each week after he shall have received the first of said reports, transmit a copy of the said reports, to the Governor, who shall, as soon as the sum hereby appropriated shall have been expended in the payment of said bounties, notify all persons interested therein of such fact by a publication of such notice in some newspaper printed and published at the city of Saint Paul, in said State of Minnesota, for three successive days.

SEC. 6. For a failure on the part of said measurer to perform any of his duties under this act, or for any mismeasurment of such grasshoppers and their eggs, he shall be deemed to be guilty of a misdemeanor, and be subject to pay a fine of not less than ten dollars nor more than one hundred dollars, or be imprisoned in the county jail for a term of not less than thirty nor more than ninety days, in a suit or proceeding to be prosecuted in the name of the State of Minnesota, in the same manner as is provided by law in other cases of misdemeanor.

SEC. 7. Upon the presentation of such certificate to the county auditor, he shall issue a certificate to the person entitled thereto for the amount due him, (a form of which certificate shall be furnished by the State Auditor.) and shall make an order upon the State Auditor for the amount thereof, and the State Auditor shall draw his warrant upon the State Treasurer for that amount, in favor of the parties holding said certificates, which shall be paid by the State Treasurer on presentation: *Provided*, That all certificates presented to the county auditor for payment shall be by him filed and preserved in his office, and he shall present such certificates to the board of county commissioners, who shall audit the same in the manner now provided by law for auditing accounts against counties; and no money shall be drawn from the State treasury until such certificates have been audited and allowed in the manner herein provided. And that no money shall be paid under the provisions of this act at any time prior to the fifteenth day of July, A. D. eighteen hundred and seventy-seven, and that the money hereby appropriated shall only apply to certificates duly made and filed with the Auditor of State on or before said day; that at the time after the State Auditor shall ascertain the total amount of all claims and certificates so filed, and if the same

shall exceed in amount the sum of one hundred thousand dollars, then the said claims shall be paid pro rata, and no other or greater amount than said sum of one hundred thousand dollars shall ever be paid under the provisions of this act: *And provided further*, That if the amount hereby appropriated is not sufficient to pay the certificates in full, the balance shall be paid by the counties respectively, according to the amount due on said certificates as issued by such county.

SEC. 8. Every male inhabitant of the several townships in the said afflicted counties, being above the age of twenty-one years and under the age of sixty years, excepting paupers, idiots and lunatics, shall be assessed by the board of supervisors of said township to work one day in each week in said township, during the period hereinbefore mentioned, for the paying of bounties for the purpose of catching and destroying grasshoppers and their eggs, for five weeks from the time said grasshoppers shall become large enough to be taken; and the amount of work to be so assessed shall not exceed five days in all.

SEC. 9. The supervisors aforesaid shall make a list of the names of all persons against whom said tax shall have been assessed, and place in a column opposite each name on said list, the amount of labor assessed against such person, and shall direct the town clerk to make a certified copy of each list, after which the town clerk shall deliver the several copies to the respective overseers of the highways of said townships.

SEC. 10. The overseers of highways shall give at least two days' notice to all persons assessed to work as aforesaid, living within the limits of their respective districts, of the time and places where and when they are to appear for that purpose, and with what implements.

SEC. 11. Every person liable to work, as provided for in this act, may commute for the same at the rate of one dollar per day, in which case such commutation money shall be paid to the chairman of the board of supervisors, to be applied and expended by him for the destruction of grasshoppers and their eggs, and he shall be authorized and required to hire and engage some suitable and efficient person to work in the place of said person so commuting, and to pay them the sum of one dollar per day for his services; and every person intending to commute for his assessment shall, within five days after he is notified to appear and work as aforesaid, pay the commutation money for the work required of him by said notice, and the commutation shall not be considered as made until such money is paid.

SEC. 12. Every person so assessed and notified, who shall willfully neglect or refuse to commute or work as provided by this act, shall be guilty of a misdemeanor, and shall, on conviction thereof, be liable to pay a fine of not less than two dollars nor more than ten dollars, or by imprisonment in the county jail not more than ten days, or both, in the discretion of the court, in a suit to be prosecuted in the name of the State of Minnesota, in the same manner as is provided by law for prosecutions of misdemeanors.

SEC. 13. There shall be appropriated, out of any moneys in the treasury of this State, not otherwise appropriated, for the purpose of carrying out the provisions of this act, the sum of one hundred thousand dollars.

SEC. 14. The board of county commissioners of any county in this State afflicted by grasshoppers, shall have the right, if, in their judgment they see fit, to employ one or more persons in each township in said county with such implements or mechanical contrivances as may prove most efficient to destroy the grasshoppers, from the first day of April to the first day of August in each year, paying such persons either by the day or a specified sum for the amount captured and destroyed. The compensation of such person shall be paid out of the general fund of the county: *Provided further*, That parties employed and paid by the county commissioners shall not receive any other or further compensation under the provisions of this act.

SEC. 15. This act shall take effect and be in force from and after its passage.

Approved March 1, 1877.

More complicated than the others, this Minnesota act has certain special features which are intended to meet the peculiar emergency in that State. Yet I do not think the act is as clear or will prove as effectual as the first Kansas act. In addition to this bounty act, the Minnesota Legislature passed another appropriating $75,000 for the purchase and distribution of seed grain to the sufferers from locust injuries.

If the States of Iowa, Nebraska, Colorado and Texas would enact similar laws, appropriate to their respective requirements, there would be such combined slaughter of the insects that in all the more thickly settled portions of the country subject to invasion, they would be virtually annihilated before they acquired wings. It is by some such uniform and concerted warfare, calculated to prevent the insects that hatch out in said country from flying back to restock the Northwest, that the people may hope to measurably conquer the foe and lengthen the periods of immunity between the invasions.

AREA IN WHICH EGGS WERE LAID.

The locust invasion of 1876 was remarkable for the very large area in which eggs were laid. This was almost coextensive with the area invaded and is indicated in the map (Fig. 16), though the counties of Murray, Cottonwood, Watonwa, Brown and parts of the adjacent counties, in Minnesota, which are there included, should, as already stated (*ante*, p. 62) be excepted.

The eggs are most thickly laid in the eastern, more settled and more generally cultivated portion of the belt, and less thickly in the thinly settled prairie country. Another noticeable feature of this invasion was, that, from Minnesota to the Gulf, egg-laying continued till the females were buried in the first snows or killed by the first severe frosts. Far into November and after the thermometer had frequently fallen several degrees below the freezing point, I found them rousing from the night's benumbing cold, and, under the increasing warmth of the sun toward noon, laying in exposed and sunny places. Hiding in the dry grass or under other shelter where they were unseen during the cooler parts of the day, one might pass through a country at such hours without suspecting their presence; while at noon they would start at every foot step. And only the day before the last one was buried beyond recovery by a severe snow storm, I found females not only laying, but many of them having eggs in the ovaries that were yet quite small—thus showing that they prematurely perished by winter's chilling blasts.

CONDITION OF THE EGGS.

The farmers of the West have been deeply interested in the condition of the eggs during the Winter, and have naturally hoped that, as the season advanced, the vitality of these eggs might in some way or other be impaired. I have, from time to time, examined eggs from many different localities, and the following inquiries, with my answers, as published in the *Rural World* at the time, will serve to indicate the generally sound condition they were in, up to the first week in February.

I send you, by to-day's mail, specimens of grasshopper eggs procured on my farm, as follows: Specimen No. 1 was procured in house yard, where exposed to constant tramping; No. 2 from loose soil, in an exposed position; No. 3 from a foot-path, on south side of hedge. Please examine and report upon condition of the several specimens, and oblige. DR. W. F. RUTBOTTOM.
RHEA'S MILL, COLLIN CO., TEXAS, January 16.

All three lots were sound, and the embryon so far advanced that a week's mild weather would hatch the young.—[Since this was written they have all hatched.]

I have for sometime past been carefully examining the deposits of locust eggs in this vicinity, and find them nearly addled, very few indeed being found, and those only upon sod, in which segmentation cannot be detected with the aid of a small magnifying glass. Other observers here report the same condition, and we are satisfied that no fears need be entertained of damage from the young brood, provided the addled eggs do not hatch. Can the development within the egg be arrested, and yet go on upon the return of proper conditions? Some of us have been led to fear that such might be the case, by the plump, fresh appearance of the little rascals, after repeated freezing and thawing. Your answer to the above question will be thankfully received by many of us here, who depend upon our farm crops for a living. A. ROBERTS.
LINCOLN, NEBRASKA, January 13, 1877.

It is difficult to get at what Mr. Roberts exactly means. Eggs once "addled" of course never hatch, but "segmentation" does not indicate an addled condition. On the contrary, it indicates development. The best way to get positive information is to send me specimens.

Herein find eggs of Rocky Mountain Locust. What is their condition?
LAMAR, Barton county, Mo. A. A. DYE.

The eggs are below the average size, and part of them dead. The probabilities are that few of them will hatch.

I am very much interested in this "hopper question," as great quantities of eggs were deposited in this section last Fall. I have read carefully the proceedings of the Conference in Omaha. Also, some of your articles in the New York *Tribune;* but find nothing on the point of what advancement the eggs make towards hatching in the Fall. Of all the egg sacks examined (which were not addled), the eye of the hopper could be discerned through his particular covering; and, on removing the covering, the hind legs could be raised clear of the body, by the aid of a pin. The question is, after making that advancement, will they live through the Winter and hatch out in the Spring? S. C. BASSETT.
GIBBON, NEB., January 10, 1877.

Yes! I have had them in that advanced condition; kept them till the first of the year; then brought them into a hatching temperature, and they hatched.

I have just been reading the report of your meeting at Omaha, on the grasshopper, and as I live in this great grasshopper country, and am a firm believer in your treatise and sayings on the pest, I have some questions to ask. I made some observations last Fall, and up to the time the ground froze up, of their eggs; and would ask, if young eggs will hatch that were so far advanced that, in breaking open the egg-sack, you could distinguish the hopper's eyes and the shape of his legs? Now, it seems to me, that eggs that far advanced must certainly be destroyed by the cold weather we have had of late. Am I correct? By answering this, you will confer a favor upon one who is greatly interested. It is the prevailing opinion of most of the people that we won't be hurt much in the Spring. Thus far there has been very little prairie burned, and am in hopes by your advice and others, who understand the nature of the hopper, to give them a warm reception in the Spring, if they hatch to any great number.
MINNEAPOLIS, Ottawa county, Kansas. M. A. ARNOTT.

I would not dare to give hope without examining specimens. Send some along. Little hope can be built on the advanced condition of the eggs. Better prepare to give the young fellows a warm reception in Spring.

I have sent you by mail to-day some hopper eggs, taken out of the ground on December 25. They have been in my store ever since. I have some eggs that have never been outside my store since September, and also some taken out of the ground the same day that the ones I send you were. I am watching them as closely as I can. WM. C. RALLS.
LE SEUER, Minn.

The eggs are very small, as the pods also, and fully one-half of the eggs are addled.

I wish your opinion in relation to a question under discussion here, viz: Will the grasshoppers, that are now in a fleshy or larval state, hatch? The eggs that were laid during the earlier part of the season that the 'hoppers were here, have developed into a larval state, and many persons claim that, because of that development, they will perish by the Winter. My opinion is, that they are all right and will hatch. What do you say. The later laid eggs are yet in a fluid state.

COUNCIL BLUFFS, Iowa. H. C. RAYMOND.

I am, as will be seen above, of your opinion.

I have to-day been examining grasshopper eggs, and where they are thickest I have found worms or larvæ like the enclosed. Are they the white worms that were in the egg cocoons last Fall, or are they something else? The grasshopper eggs seem in good condition; but we are having very warm weather now, and the frost is coming out of the ground. The weather is much like that we had in '67–8. I found no worms in the cocoons with the eggs. WM. DUNN.

SYRACUSE, Otoe county, Neb., Feb. 1, 1877.

The locust eggs are yet sound, but I have some hope that the recent very warm weather, if succeeded by severe cold, will cause the death of a large portion. [The grubs preying on the eggs were the Ichneumon larva described on p. 96, Fig. 24].

Friend Clarkson, agricultural editor of the Iowa *State Register*, recommends that grasshopper eggs be sent you for examination, and I send by mail to-day, in a tin box, some eggs which have been taken from the ground under the following conditions: As you will find, I have packed them in layers in the box, with paper between. The top layer was taken from black loam on a piece of ground apt to keep dry—that is, well drained—and have never been completely thawed since frozen in the beginning of Winter. The middle layer was taken from sand, and has repeatedly been frozen and thawed out—the water from thawing snow running over and completely saturating the sand daily for some days. The bottom layer is from low land, which was submerged in five feet of water for ten days after they were deposited in the Fall, the ground remaining muddy till frozen, afterwards covered with snow; the continued thawing and evaporation of the last few days have removed the snow and left the surface for two inches in depth thawed and dry. For the past few days we have had it warm in day time, but freezing at night. The place is in Adams county, ninety miles east of Council Bluffs, and forty miles north of the Missouri line.

WM. THOMPSON.

MT. ETNA, Adams County, Iowa, January 30, 1877.

The eggs from all three of the different positions are so little advanced in development that it is impossible to say positively that they are all sound. The liquids have scarcely begun to thicken. So far as I feel warranted in giving an opinion, I should say that they are all sound—those of the third batch only, giving some evidence of injury by the weakening of the integument. [All hatched since.]

By this mail I forward to you one box of the grasshopper eggs. Are they in a good state of preservation, and will they hatch in the Spring if everything hereafter is favorable?

Enclosed I hand you an extract from the *Interior*. You will see the question raised there as to whether an egg can be partially hatched, as these are, and then the process delayed for a long time, and afterwards resume the work and go on to completion. All our people here regard this proposition with considerable doubt. In fact, they deny that such a thing can be done. I should infer that you hold that these eggs will hatch, notwithstanding the interruption. Will you please enlighten us fully as to why this is thus?

HUTCHINSON, KANSAS, January 29, 1877. J. B. SHANE.

The article alluded to by Mr. Shane closes with the following editorial remarks:

Without arrogating to ourself any special wisdom on the subject, but reasoning from analogy only, should decide that in the case of the eggs referred to by Major Shane—and in fact, all the eggs in the country in the same condition—incubation has been arrested, and that once arrested, it has ceased forever. In all life that emanates from an egg (and what life does not, except the vegetable?) when its development is arrested during incubation, it is a permanent paralysis; in other words, it is death. We say that, analogically, this should be so, but we may be wrong.

The advanced development of the locust embryo in the eggs sent by Mr. Shane, argues nothing but very early hatching as soon as Spring opens. Their vitality is unimpaired, as Mr. Shane may soon prove by bringing them into a warm room. I have had such forward eggs hatch the present Winter after various periods of freezing.

Enclosed, please find eggs of Rocky Mountain Locust. They were taken on my farm, on southeast quarter of section 19, township 28, range 27, county of Lawrence, and State of Missouri.
February 2, 1877. W. R. GOODMAN.

Fully ten per cent. of the eggs are dead and more or less decomposed. As in other instances from Missouri, a number of the masses, as also the eggs, are far below the average size, and, compared with those received from the farther West and South, are evidently lacking in vitality. They were doubtless the last eggs laid, just before Winter, and when the insects were nearly exhausted.

I, like many others, desiring some information regarding our coming crop of *Grasshoppers*, wish to ask a few questions on the subject. In examining the eggs late last Fall, I found many formed so one could see the eggs and form, and upon recently examining them, I find they are in the same condition as three months ago. Now, will those thus formed pass through the winter and hatch *in the Spring*, or will they be destroyed? Other eggs are in the same state, for all I can see, as when deposited. Now, is it likely the whole crop will mature in the Spring? Please inform me regarding it. Any information you can give on the subject will be thankfully received by myself and many others, who feel afraid of the results of the coming Spring, with the great amount of eggs deposited.
PLYMOUTH, Nebr., Jan. 21, 1877. J. E. ROE.

There is no doubt but that the eggs will mature under ordinary Spring conditions. The fact of some of them being so much more advanced than others, will not, in the least, interfere with their hatching.

I send you this day a box of locust eggs packed in earth. Please tell us whether they will hatch?
WICHITA, Kans., Feb. 2, 1877. A. B. ARMENT.

The eggs were all sound and yet in the fluid state.

Eggs received and examined almost every day during February and up to March 10th, were, like those examined earlier in the season, in the main sound. A certain proportion of the young hatched during the mild Fall weather we had in October, while the unusually warm weather that occurred the last ten days of January and forepart of February caused still larger numbers to hatch, not alone in the southern portion of the territory occupied, but even as far north as Dakota. The young that thus prematurely hatched perished by subsequent frosts, for I have proved that while the eggs are unaffected by intense freezing, the young insects are killed at 15° F. As the Winter was in some respects remarkable, as well for the warm weather which thus caused the eggs to hatch, as for the many and sudden changes of temperature; and as the eggs have not been injured thereby to any appreciable extent up to the date of this writing, I will place upon record, in this connection, the thermometrical observations made at St. Louis from November 15, 1876, to March 10, 1877:

Temperature at St. Louis, Mo., of Winter of 1876–7.

1876.	Max.	Min.	Mean.
November 15	41	30	37
16	44	35	39
17	47	40	44
18	47	25	34
19	36	22	32
20	45	31	38
21	47	32	37
22	42	23	35
23	45	31	36
24	51	32	41
25	47	31	40
26	38	30	34
27	45	31	39
28	39	23	28
29	33	27	29
30	27	15	16
December 1	20	4	14
2	24	5	16
3	29	12	23
4	34	24	30
5	45	24	34
6	47	33	38
7	47	31	39
8	40	3	15
9	11	—5	5
10	37	9	31
11	55	28	44
12	60	36	48
13	50	38	42
14	38	18	27
15	45	12	36
16	44	4	12
17	27	13	20
18	22	2	16
19	37	18	28
20	43	23	33
21	43	23	34
22	37	20	26
23	24	13	19
24	19	11	15
25	21	13	18
26	21	13	18
27	24	15	21
28	26	17	21
29	19	10	14
30	21	4	15
31	34	17	24
1877.			
January 1	24	13	14
2	21	8	15
3	26	11	21
4	42	19	33
5	42	29	36
6	43	32	37
7	35	13	21
8	13	—4	7
9	28	1	19
10	35	21	31

1877.	Max.	Min.	Mean.
January 11	52	32	40
12	32	14	19
13	27	10	22
14	34	22	31
15	43	23	33
16	23	9	18
17	40	20	35
18	46	35	42
19	50	39	45
20	46	21	22
21	37	19	32
22	37	23	26
23	32	10	24
24	31	19	26
25	48	22	36
26	51	32	39
27	50	31	41
28	57	33	47
29	57	38	49
30	65	48	57
31	66	53	59
February 1	69	50	59
2	56	44	49
3	48	35	37
4	46	32	39
5	40	28	33
6	49	34	41
7	53	38	46
8	47	36	42
9	50	33	44
10	58	37	48
11	58	42	52
12	52	29	32
13	36	28	33
14	44	30	38
15	53	31	44
16	47	38	40
17	50	34	42
18	66	34	53
19	58	34	37
20	48	27	39
21	65	34	51
22	53	44	47
23	44	33	38
24	35	29	32
25	33	28	31
26	43	28	37
27	48	28	40
28	50	32	43
March 1	47	39	43
2	47	37	39
3	49	18	29
4	32	14	26
5	40	26	34
6	55	30	46
7	57	36	47
8	55	18	23
9	23	9	18
10	41	16	31

From meteorological data obtained at Lawrence, Kansas, and furnished by Prof. F. H. Snow, and from reports from many other parts of the country, it is evident that the high temperature of January and February was general throughout the country between the Rocky Mountains and the Mississippi, reaching its acme on the 18th of the latter month. Dr. Engelmann found the first maple in bloom, in St. Louis, on the 19th of February, and has no notes of such early blooming in the past forty years during which he has recorded observations.

PROSPECTS FOR 1877.

A large number of the readers of this Report would feel sadly disappointed were I to conclude this review of our last locust invasion without expressing an opinion as to the future prospects. To give an opinion as to the happenings of the future is somewhat hazardous where there are so many possible contingencies that are altogether beyond man's ken; yet one who is careful in his expressions and statements need never hesitate to advance them. With a reputation at stake, I have not hesitated to do so in the past, and wherever I have felt warranted in making a positive prediction, or in giving an unqualified opinion, subsequent events have justified the same. I will, therefore, give my views of the prospects for the year 1877, as they appear from the condition of things at this writing (March 10th); premising only that, in forecasting future events in connection with this insect, I would rather err on the bright than the gloomy side.

The area over which eggs have been laid is, as we have have already seen, unusually large. It was quite generally noticed that the females were less particular than is their wont in choosing clear and sunny spots for purposes of oviposition, and, after careful consideration of the subject, I should say that, at the lowest estimate, two out of every one hundred acres throughout the area indicated by the heavier lines in my map (Fig. 16) are thickly supplied with eggs, and by this I mean mean that the eggs will average 3,000 to the square foot. In other words, throughout this whole country the southern slopes, sandy, gravelly, and other bare spots, roads, paths, etc., in which the females prefer to lay; compare, on an average, as 2 to 100 with the northern slopes, timber, rank prairie, moist and recently cultivated lands, which are generally avoided. At these low estimates there would, under favorable circumstances, enough young locusts hatch out to devour everything green, not only in the area stated, but over the whole United States, were they evenly disseminated throughout the country. We have already seen that the bulk of the eggs yet remain sound, and, notwithstanding such as have been destroyed by natural enemies and all other

causes, and such as have prematurely hatched, those yet to hatch will give birth to locusts enough, under ordinary conditions of weather, to lay waste the earth and render it as bare of vegetation as it is in midwinter, before they take their departure. This is not overstating the case, and the farmers of the threatened region should count on such a probability and do all in their power to avoid it.

The insects have already hatched out largely toward the Gulf, and the bulk of them will hatch in lat. 35° about the middle of the month. They will continue to hatch most numerously about four days later with each degree of latitude north, until along the 49th parallel the same scenes will be repeated that occurred in Southern Texas seven or eight weeks before. In the S. W. counties of Missouri hatching will be at its height about the second week in April; in the N. W. counties a few days later. Wherever they hatch in quantities, the injury will at first be confined to particular fields and locations; but as they increase in size they will become more and more injurious and widen the area of their devastations until, if nothing be done to prevent it, they will ruin most crops by the time the bulk of them acquire wings—leaving, in extreme cases, no plant untouched but the little *Amarantus Blitum*. This will occur in from six to eight weeks after hatching, and the winged swarms in South Texas will be leaving that country early in May or about the time the young are beginning to hatch near the British American line.

The unfledged locusts will travel in no especial direction, but in different directions, and they will not extend, on an average, more than ten miles east of any point where they hatched out. The winged insects, on the contrary, will take their departure in a northerly or northwesterly direction—at least, this will be the prevailing direction of those which rise during the months of May and June. The course of those which rise later may not be so constant. Those that escape from the many vicissitudes that will befall them in the Mississippi Valley, and which are free from disease or parasites when they start, will, in all probability, eventually reach the extreme Northwest, and be largely lost to view beyond our northern boundary. They will not fly eastward so as to do any serious damage beyond the line indicated in the map.

Such are the probabilities for the Spring and Summer. They are not particularly encouraging!

I will now state a few of the modifying circumstances and of the possibilities that will lighten the darkness of the picture and may very materially diminish the prospective damage.

Firstly—The farmers are in much better condition to withstand the temporary loss than they were in the Spring of 1874.

Secondly—They are far more thoroughly posted as to the prospects and better organized to fight the enemy. Correct information has been very widely circulated through the media of special reports and of the agricultural press. The bounty laws enacted during the winter will incite to action and will have a beneficial effect. The people are anticipating and preparing where two years ago they were comparatively indifferent. They are profiting by the experience of 1874–5. This is more particularly the case in Kansas, Nebraska, Iowa and Minnesota, and I regret to say less so in Missouri; for in some of our counties which are threatened, there is no organization and little preparation to meet the enemy.

Thirdly—I could not help noticing, and the same thing was remarked by many others, that quite a number of the insects observed last Fall, were much beneath the average size and generally darker than the typical specimens. Also a certain proportion of the eggs that I have received during the Winter, were far below the average size and much more predisposed to rot than the rest. I am strongly of the opinion that such specimens belonged to the swarms which developed in Minnesota and thereabouts, and which, after being repulsed in their efforts to get N. W., joined and formed part of the larger swarms which came from the farther N. W. The insects that hatched in Minnesota were in many instances the 3d and 4th generation bred there, and their degeneracy was very generally observed. Thus, expressions to the effect that the locusts there last Summer, were "used up," "tired out," etc., were common among farmers, and Mr. Whitman notes (Special Report for 1876, p. 12) the gradual decrease in the extent of the breeding grounds from year to year. More eggs have also rotted and the parasites have been more numerous there than elsewhere; while the injury has not compared to what it was in our State in 1875. The greater longevity of many of the insects of 1876 as compared with those of 1874, would also indicate that they were bred south of the region where the species is permanent and comes to greatest perfection. We may therefore expect that, as compared with 1875, a larger proportion of the young that will hatch in 1877, will be weakly and soon perish; for I know from my breeding experiments that there is great difference in constitutional vigor between them.

Fourthly—There is a bare possibility that, after the bulk of the young have hatched, and before they have commenced to do serious harm, we may have such unseasonably cold and wet weather as to kill them by myriads, and effectually weaken their power for injury.

Fifthly—Let the destruction be as complete as it well can, and

there is every assurance that the insects will vacate the country in which they were born, soon enough to permit the planting and harvesting of a great many of the more important vegetables, and with a favorable Fall, a good crop of corn. This is more particularly true of Missouri, and the country S. of the 44th parallel and E. of the 100th meridian, which country I have designated as outside the species' habitat. It is less true of the country W. and N. of those lines.

As to the prospects later in the year, it is impossible to predicate with the same degree of assurance. There were no locusts to do harm in Manitoba in 1876, and it would seem that the Saskatchawan country must have been more or less depleted by the swarms which overspread our country. I am inclined to hope and believe that there will not be another general invasion next autumn, and that the people of Texas, Indian Territory, Arkansas, Missouri, Kansas, Nebraska, Iowa, South Dakota and even Minnesota, may expect immunity for a few years to come; after the hosts which are about to hatch are destroyed or wing themselves away. There may be partial injury from their progeny in 1878, or even 1879, in parts of the country named, especially toward the N. W.; but there will be no general destruction. In Missouri we may confidently hope for immunity for from seven to ten years.

In conclusion, I would urge our farmers in the threatened country to prepare to carry out the recommendations given in this Report; to provide themselves with northern grown, early-ripening, seed-corn; to sell no hogs nor poultry; and to diversify their crops by growing more tuberous and leguminous plants.

In the language of the Omaha Conference report: "Above all, do not get discouraged! Come what may, do not ask for outside aid! We do not believe there ever will be any need of it: it is, in the end, demoralizing. * * * * *

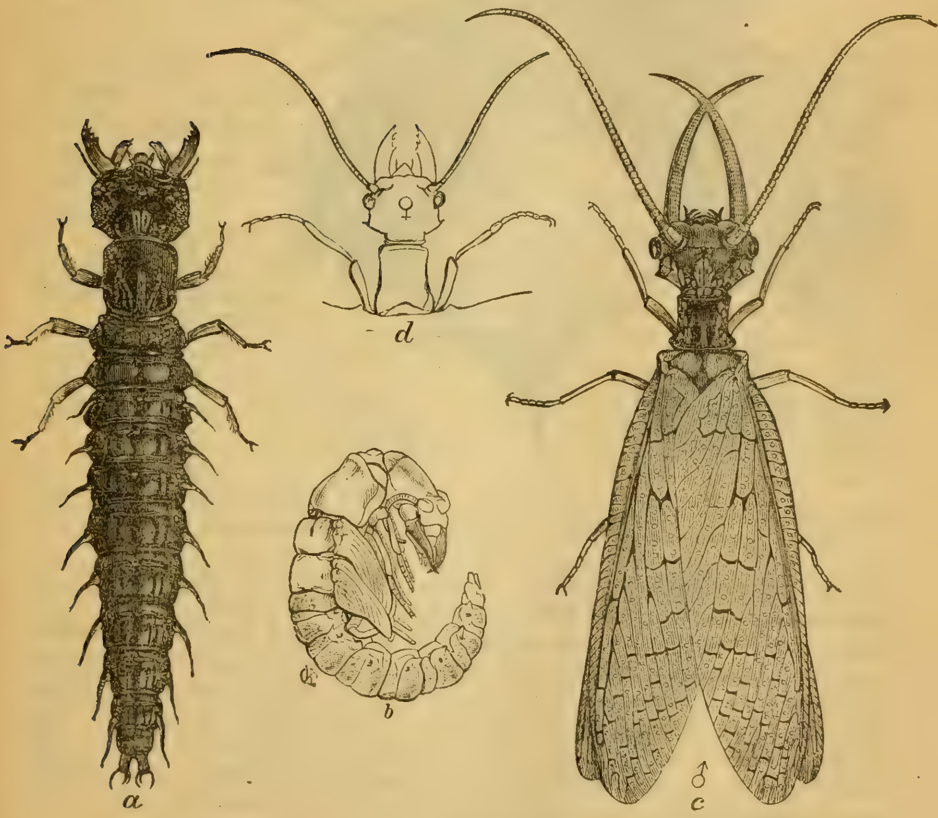
"There is no part of the country that is not subject to meteorological or entomological excesses, and in the long run the locust is not more injurious than are some insects in other parts of the country. When we think of the famine and utter destitution that at times overtake some of the Eastern peoples, we may well thank the Almighty that we live in a land of such resources and promise. The threatened country has prospered in the past: it will prosper in the future; and in proportion as we meet this locust enemy with enterprise and concerted, intelligent action, in that proportion shall we vanquish it."

INNOXIOUS INSECTS.

THE HELLGRAMMITE.—*Corydalus cornutus* (Linn).

[Ord. NEUROPTERA ; Fam. SIALIDÆ.]

[Fig. 30.]



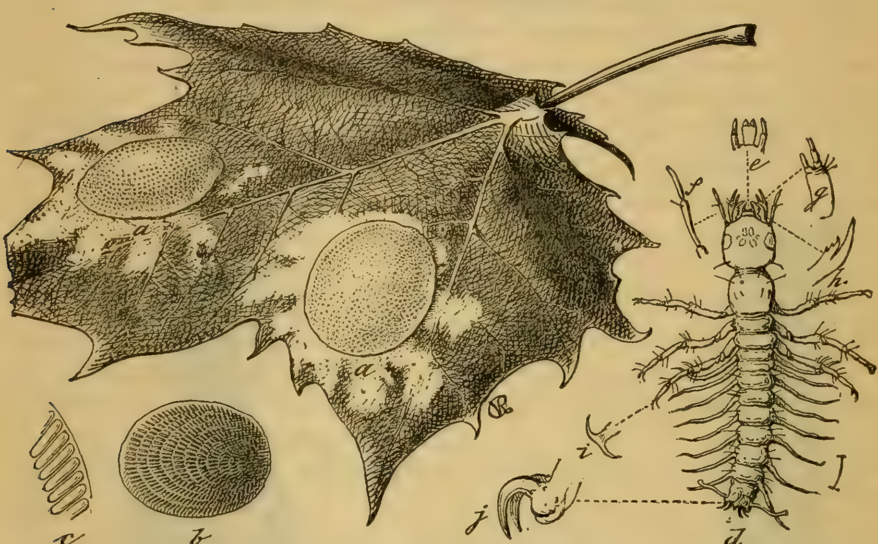
THE HELLGRAMMITE:—*a*, larva; *b*, pupa; *c*, male fly; *d*, head and jaws of female.

The following paper "On the curious Egg-mass of Corydalus cornutus (Linn.) and on the Eggs that have hitherto been referred to that Species," read by me at the last meeting of the American Associa-

tion for the Advancement of Science, will correct and supplement the article on the same insect published in my 5th Report:

Our largest Neuropteron, belonging to the family Sialidæ, is *Corydalus cornutus.* It is not uncommon in the Eastern and Middle States, and is known in the Mississippi Valley by the vulgar name of Hellgrammite. In the female the mandibles are quite formidable, but in the male they are curiously modified, and form long, incurved, smooth, prehensile organs of the form of the finger of a grain-cradle, and evidently of use in enabling him to embrace his mate. The larva of this fly occurs in running streams, living mostly at the bottom, and hiding under stones in the swiftest parts. It has strong jaws, and in addition to the ordinary stigmata, it is furnished with two sets of gills, one set lateral and filamentous, the other ventral, and each composed of a sponge-like mass of short rust-brown fibres.

[Fig. 31.]



Corydalus cornutus:—*a*, *a*, egg-masses attached; *b*, one detached, showing lower surface—all rather below average size; *c*, a few eggs of the outer row; *d*, the newly-hatched larva; *e*, labium; *f*, antenna; *g*, maxilla; *h*, mandible; *i*, tarsal claw; *j*, anal hooks—all enlarged.

Its body terminates in two fleshy tubercles, each armed with a pair of hooks. It is best known in the full grown condition when, in seeking for a place in which to undergo its transformations, it travels and climbs on the shores of our rivers, and sometimes to long distances. Called a "crawler" by fishermen, it is greatly esteemed as bait. The pupa is quiescent and formed in a cavity in the ground. The supposed eggs of this insect were figured and described in the *American Entomologist*, and in the Fifth Missouri Entomological Report, as oval, about the size of a radish seed, and deposited in closely set patches of fifty and upward upon reeds and other aquatic plants; and they have since been frequently referred to, no one questioning the accuracy of the conclusion of their discoverer, the late B. D. Walsh.

About the middle of last July, in sailing up the Mississippi river between Bushberg and St. Louis, my attention was attracted by sundry white splashes on the leaves of various plants that overhung the water; which splashes looked, at a distance, not unlike the droppings of some large bird. Approaching more closely to them, how-

ever, they were seen to consist of sub-oval or circular swellings, with more or less white splashed around them; and upon still closer examination, they proved to be egg-masses. They were generally attached one to the upper surface of a leaf either of Sycamore, Elm, Cottonwood or Grapevine; but sometimes there were several on the same leaf, and at others they occurred on both sides of the leaf. It was evident that the leaves were objects of attachment only, * and from the fact that only those which overhung the water were selected by the parent, it was natural to infer that the species was aquatic in its larva state. Yet the egg-masses greatly puzzled me, as indeeed they did all naturalists to whom I referred them; for the eggs of the larger water-beetles were known, those of *Corydalus* were supposed to be known, and there was only one other water insect in North America, viz: *Belostoma grandis*, large enough to be capable of laying such a mass. But these eggs were evidently not Heteropterous.

Patiently waiting till the eggs hatched, I recognised at once, in the young larva, the characters of *Corydalus cornutus*, with the full grown larva of which I was familiar; and upon dissecting the abdomen of a female Hellgrammite, the nature of the curious egg-masses was fully confirmed in the perfect identity in shape and arrangement of the eggs composing them, and of those in said abdomen.

The egg-mass of *Corydalus cornutus* is either broadly oval, circular, or (more exceptionally) even pyriform in circumference, flat on the attached side, and plano-convex on the exposed side. It averages 21 mm. in length, and is covered with a white or cream-colored albuminous secretion, which is generally splashed around the mass on the leaf or other object of attachment. It contains from two to three thousand eggs, each of which is 1.3 mm. long, and about one-third as wide, ellipsoidal, translucent, sordid white, with a delicate shell, and surrounded and separated from the adjoining eggs by a thin layer ot the same white albuminous material which covers the whole. The outer layer forms a compact arch, with the anterior ends pointing inwards, and the posterior ends showing like faint dots through the white covering. Those of the marginal row lie flat on the attached surface; the others gradually diverge outwardly so that the central ones are at right angles with said object. Beneath this vaulted layer the rest lie on a plane with the leaf, those touching it in concentric rows; the rest packed in irregularly. Before hatching, the dark eyes of the embryon show distinctly through the delicate shell, and the eggs assume a darker color, which contrasts more strongly with the white intervening matter.

The young crawl from under the mass, and leave the vaulted covering intact. They all hatch simultaneously, and in the night.

The egg-burster† has the form of the common immature mushroom, and is easily perceived on the end of the vacated shell. The young larvæ crawl readily upon dry surfaces, with their tails hoisted in the air, and live for a day or more out of water; but when hatching out over an aquarium, they instinctively drop to the water, where, after resting for a while, with their bodies hanging down and their heads bent forward at the surface, they swim to the bottom by whipping the body from side to side very much as a mosquito wriggler does. Here they secrete themselves and remain until, in the course of a few days they perish. They cannot be reared in confinement, and running water is doubtless as essential to them as to the full grown larva.

The newly hatched larva is almost colorless and differs from the full-grown larva, in the relatively longer legs and lateral filaments; in these last being smooth and not

* Since this was written, I learn from Mr. Lintner, of Albany, N. Y., that he has found these egg-masses attached to rocks in the Mohawk river, though he had no knowledge of their parentage.

† I am not aware that this special structure has been named. It is generally, if not always, a part of the ambion, and is common to many insects, though varying much in form. It may be known as the *ruptor ovi*. Dr. Hagen has called it the "egg-burster," while erpetologists designate as the "egg-tooth," a structure having the same purpose.

clothed with short hairs; in the abdomen not bulging at the middle, and in lacking the sponge-like gills beneath. The head is wider than the rest of the body, which tapers from the first to the last joints. The prothoracic is as long as, or longer, than the meso-and metathoracic joints together, and the abdominal joints increase in length as they diminish in width. The legs are nearly thrice as long as the width of the thoracic joints; the claws are movable and about ½ as long as the tarsus; the tibia and tarsus are sub-equal; the femur somewhat longer; the coxa and trochanter about as long as the femur; there is a whorl of bristles toward the end of the femur and of the tibia. The mandibles are stout, with two principle teeth, the basal with 3 notches and the terminal one finely serrate: the maxillæ are elongate, reaching beyond the jaws, and with a simple inner and a 2-jointed outer palpus, both having basal folds, which often look like a basal joint: the antennæ are 3-jointed, and reach beyond the jaws, the middle joint longest, the terminal one nearly as long, and tapering: the labium is elongate-quadrate, tipped with two small tubercles, and with the palpi 2-jointed—the joints sub-equal. A few hairs occur on the sides of the abdomen between the filaments.

The fact that the young larva lacks the spongy masses of short fibres which characterize the mature larva, and which have been looked upon as accessory gills, would indicate that their purpose is rather to assist the creature, when it gets large, in adhering to the surface of stones at the bottom of swift-flowing waters. Though the larva can live for some time out of water, even when young; yet, until it attains its growth it is strictly aquatic, abounding most in rapid flowing streams, and especially such as have a rocky bottom, upon which it crawls slowly about, feeding upon other aquatic insects, especially Ephemerid larvæ, some of which, taken from the stomach, I have been able to recognize as belonging to the genus *Palingenia*.

[Fig. 32.]

PROBABLE EGGS OF BELOSTOMA.

[Fig. 33.]

BELOSTOMA GRANDIS.

Mr. J. H. Comstock of Cornell University, who has for several years studied the habits of this larva around Ithaca N. Y., generally finds it in the most rapid portions of streams, where it dwells mostly under stones. He has captured numbers by turning over large stones and allowing the current to wash the larvæ into a dip-net; and he is of the opinion, which my own observations support, that the species lives three years in this larval condition.

By carefully studying the anatomy of the species, he has also discovered an additional pair of rudimentary spiracles on the hind part of a prominent fold between the meso- and metathoracic joints.

As to the nature of the eggs (Fig. 32) that have hitherto been mistaken for those of Corydalus, I can only sur-

mise. The specimens from which the figure was made were destroyed with the Walsh cabinet in the Chicago fire; but I have a very distinct recollection of them, and judging from the nature of the eggs of *Perthostoma*, with which I am familiar, there is little doubt in my mind that these supposed eggs of Corydalus really belong to *Belostoma grandis*, (Fig. 33) which is the only aquatic Heteropterous insect of sufficient size to lay them.

THE YUCCA BORER—*Megathymus yuccæ* (Walker.)

[Ord. Lepidoptera; Fam. Hesperidæ]

Having, during the year, reared this interesting butterfly from the egg, so as to watch its growth, I can supplement the article published a year ago by stating, positively, that there is but one generation annually, and that the characteristic glistening powder that covers the full grown larva, is not secreted till toward the last molt. The larva referred to on p. 181 of my Eighth Report, as being kept in a tin box, and fed solely on the leaves, lived till the 25th of September. It formed a perfect cylinder of silk and excrement around the bottom of the box, fastening thereto the ends of the cut leaves, so that the cylinder was necessarily broken each time the leaves were changed. This specimen went through no less than seven molts at irregular intervals of 10, 11, 24, 14, 61, 15 and 21 days respectively. It changed but little in appearance, except in becoming somewhat paler, after the second molt, and died when about three-fourths grown—death resulting, I think, more from the mould that formed from the excrement, and which it was impossible to prevent, than from the nature of its food. It is doubtful if so many molts are suffered in more natural and healthy conditions.

Another specimen that entered a Yucca plant in the garden of my friend, Dr. G. Engelmann, throve admirably, extending over a foot beneath the ground, and attaining full growth by the end of September; while a third, in a potted *Yucca aloifolia* in-doors, hollowed out the entire root, pupated on the 26th of January, 1877, and gave out the imago on the 25th of the following month.

INDEX.

ERRATA.

Page 6, line 26 insert after "moth" (*Euphanessa mendica*, Walk.)
Page 15, line 3 for "entite" read "entire."
Page 50, explanation of cut, for "*e*" read "*c*."
Page 50, line 3 from bottom, for "Hubner" read "Huebner."
Page 54, last line, in place of the comma, write "is."
Page 55, line 1, for "the other" read "the second."
Page 55, line 9 from bottom for "m. m" read "mm."
Page 55, line 7 from bottom, strike out the "on."
Page 56, line 1, for "m. m" read "mm."
Page 56, line 2, for the last "and" read "anal."
Page 56, line 32, commence a new ¶ with "Chrysalis" and italicize it.
Page 57, for "*Spretus*" in the heading read "*spretus*."
Page 58, line 14, strike out "have."
Page 89, line 13, strike out the "i" after "embryon."
Page 98_2 line 11 from bottom, for "*Compoplex*" read "*Campoplex*."

DEPARTMENT OF THE INTERIOR.

UNITED STATES ENTOMOLOGICAL COMMISSION.

BULLETIN No. 6.

GENERAL INDEX

AND

SUPPLEMENT

TO THE

NINE REPORTS

ON THE

INSECTS OF MISSOURI.

BY

CHARLES V. RILEY, M. A., Ph. D.

WASHINGTON:
GOVERNMENT PRINTING OFFICE.
MARCH 24, 1881.

C. V. RILEY, *Chief.*

A. S. PACKARD, JR., *Secretary.*

CYRUS THOMAS, *Disbursing Agent.*

ORDER OF MATTER.

1. Introduction.
2. Table of Contents.
3. Corrections.
4. Notes and Additions.
5. Descriptions of New Species and Varieties.
6. List of Descriptions of Adolescent States.
7. List of Descriptions, mostly amplified, of Species not new.
8. List of Illustrations by Reports.
9. Classifed List of Illustrations.
10. General Index.
11. Index to Food-plants.

INTRODUCTION.

The present Bulletin has been prepared in response to frequent suggestions from those having occasion to use the nine Annual Reports on the Insects of Missouri, made by me, as State Entomologist, to the State Board of Agriculture, during the years 1868 to 1877, inclusive. These Reports contain a good deal of matter anent the Cotton Worm, the Chinch Bug, the Rocky Mountain Locust, and other insects which the Commission has studied, and were published, as required by law, in the Annual Reports of said State Board of Agriculture for the years mentioned. That method of publication was always regretted by myself and by many others, inasmuch as the reports of the Board were generally volumes of such bulk as to delay publication and render mailing expensive. By virtue of the fact that they were distributed only to members of the State legislature and to State societies, access to them by persons outside the State of Missouri was extremely difficult; while the State printing and press-work were, as a rule, of a very unsatisfactory character. To avoid some of these difficulties it was my habit to have about 300 separate copies of the entomological portion printed on better paper, at my own expense, for distribution to correspondents both at home and abroad, and it is through these, principally, that the Reports have been accessible outside the State.

The demand for the Reports and the manner in which they have been used and commended by subsequent writers can but be gratifying to the author, who feels that whatever of commendation they deserve is due to the fact that they embody results of original investigation. They contain some matter that, with present light, he would expunge, and the earlier volumes, more particularly, contain imperfections which no one appreciates more fully than himself. Many of these are attributable to isolation from other working entomologists at the time, as well as to the almost absolute dearth of entomological works of reference in any of the libraries of Saint Louis.

The general plan of the Reports, which were addressed to the intelli-

gent cultivator of the soil rather than to the naturalist, is set forth in the following passage from the introduction to the first:

Fully aware that I write for those who, as a rule, are unversed in entomology, I have endeavored to treat of each insect with as little of the nomenclature of science as is consistent with clearness of expression. Yet, as much that is of scientific interest, such as descriptions of new species, must necessarily be inserted, I have had such descriptions printed in a type of smaller size than the text, so that it can be skipped if desirable, at the time of reading, and easily referred to for comparison, with specimens which one is desirous of naming. I have also endeavored to illustrate, as far as possible, the insects of which this report treats, believing that good illustration forms the basis of successful teaching in a science with which the general husbandman is not expected to be acquainted; for the eye conveys to the mind, in an instant, what the ear would fail to do in an hour. The practical man cares little to what genus or family an insect belongs, so long as he can tell whether it be friend or foe. He must become familiarized with the insects about him without having necessarily to overcome scientific detail and technicality.

I have made no effort at a systematic arrangement of the insects treated of. Indeed, that were useless for the purpose in view; but, in order that the reader may refer the more readily to any particular insect which interests him, I have separated them into three series—NOXIOUS, BENEFICIAL, and INNOXIOUS—and attached a very full index. For the benefit of those who are making a study of entomology, I have also given, with each species, the Order and Family to which it belongs, in parenthesis under each heading.

So far as possible, I have used a common name for each insect, knowing that the scientific name is remembered with greater difficulty, and is, consequently, distasteful to many. But as popular names are very loosely applied, and the same name often refers to different insects, in different localities, a great deal of confusion would ensue without the scientific name, which is, therefore, invariably added, for the most part, in parentheses, so that it may be skipped without interfering in any way with the sense of the text.

In order to add value to this general index, I have brought together tables of contents of the nine volumes and given corrections and some notes and additions. I have also reproduced the descriptions of new species, and added a list of descriptions of adolescent states, of descriptions of species not new, of illustrations by reports, of illustrations by classification, and of food-plants.

The Reports were independently paginated, and the separate copies were often distributed before the Agricultural Report was off the press. The date of publication and distribution is given for each in the tables of contents. The nomenclature of the Reports is retained in this Bulletin, the synonomy being indicated in the notes and additions and with the reproduced descriptions. The name of the author of the species and not of the genus was always given as authority, and in the later Reports I endeavored to indicate whether or not the insect was described under the generic name which it bears, by adding the authority without a comma when the specific name is coupled with the generic name under which it was first published — *e. g.*, *Phycita nebulo* Walsh — but placed it in parentheses when a different generic name was used than that under which the insect was first described — *e. g.*, *Acrobasis nebulo* (Walsh) — except where the whole name was already in parentheses when a comma

was used for the same purpose — *e. g.* (*Acrobasis nebulo*, Walsh). The same plan is adopted throughout this Bulletin.

It had always been my intention to publish a tenth volume and to end the decade with a review of, and general index to, the whole series. Indeed, an appropriation for the tenth year's work was made and the tenth report would have been duly issued had I not been called at the time to my present work for the General Government. This Bulletin is, in a measure, the fulfillment of that intention, and is issued in the hope that it will render the Reports more serviceable to the student of insect life and to those having to deal with insects injurious to agriculture.

My thanks are due to Messrs. E. A. Schwarz and W. H. Patton, agents of the Commission, for aid in its preparation.

C. V. R.

WASHINGTON, D. C., *March* 1, 1881.

TABLES OF CONTENTS.

Neither of the first five volumes contained a table of contents, the plan of giving such having been adopted with the sixth. Most of these tables are, therefore, prepared for this Bulletin, while those of the Sixth and Seventh Reports are amplified. Those of the last two volumes are reproduced as they were originally made.

REPORT I.

[Submitted December 2, 1868; published March, 1869.]

REPORT II.

[Submitted December 2, 1869; published March, 1870.]

REPORT III.

[Submitted December 2, 1870; published April, 1871.]

REPORT IV.

[Submitted December 2, 1871; published April, 1872.]

NOXIOUS INSECTS.

BENEFICIAL INSECTS.

REPORT V.

[Submitted December 2, 1872; published April 18, 1873.]

NOXIOUS INSECTS.

INNOXIOUS INSECTS.

REPORT VI.

[Submitted December 2, 1873; published March, 1874.]

BENEFICIAL INSECTS.

INNOXIOUS INSECTS.

REPORT VII.

[Submitted at time of publication, April, 1875.]

REPORT VIII.

[Published May, 1876.]

NOXIOUS INSECTS.

REPORT IX.

[Published March, 1877.]

INNOXIOUS INSECTS.

CORRECTIONS.

A list of errata is given for each volume, and they are here reproduced with such additional ones as were previously omitted. Where foreign terms were not properly accentuated in the Reports, it was often due to the imperfect "plant" possessed by the State printer. In counting lines the running page title is omitted.

REPORT I.

Page 8, line 21, *for* being *read* were.
Page 10, line 1, *for* Figure 3,³ *read* Figure 3,².
Page 12, line 20, *for* last *read* 1866.
Page 12, line 3 from bottom, *after* February *add* (1867).
Page 12, line 13 from bottom, *for* verter *read* venter.
Page 14, line 24, *for* hermaphrodite *read* agamic.
Page 14, line 32, *for* females *read* males.
Page 15, line 10 from bottom, *for* muscle-shaped *read* mussel-shaped.
Page 22, line 2 from bottom, *for* pupas *read* pupæ.
Page 30, note, *for* F. *read* T.
Page 31, line 15, *for* 37° *read* 38°.
Page 32, line 4, *for* Kreitz *read* Kreutz.
Page 32, line 14 from bottom, *for* III *read* V.
Page 32, line 7 from bottom, *for* XIII *read* VIII.
Page 38, line 5, for *Tredeim* read *Tredecim.*
Page 47, line 16, *for* far *read* for.
Page 50, line 7, *for* none the less *read* no more.
Page 53, line 28, *for* laid *read* lain.
Page 54, line 4 from bottom, *for* hatch *read* are deposited.
Page 56, lines 5 and 12, *for* to *read* at.
Page 58, line 15 from bottom, for *Aspidiglossa* read *Aspidoglossa.*
Page 64, line 26, *omit* again.
Page 67, line 11 from bottom, *for* class *read* branch.
Page 76, line 48, *for* Climbing Rustic *read* Climbing Cut-worm Moth.
Page 78, line 46, for *unipuncta ta* read *unipuncta.*
Page 86, line 21, and wherever they occur, *for* Guénée *read* Guenée; and *for* Guén. *read* Guen.
Page 87, line 11 from bottom, *for* F. *read* T.
Page 96, note, line 4, *for* West. *read* Wesm.
Page 112, line 3, *for* abreviated *read* abbreviated.
Page 114, line 1, after "insect" read (*Stiretrus fimbriatus,* Say).
Page 120, line 30, after "Cottonwood" read (*Pemphigus vagabundus,* Walsh).
Page 123, last line, for *eriosoma* read *eriosomatis.*
Page 132, line 16, for *ampelopsis* read *ampelopsidis.*
Page 133, in heading, *for* Codling *read* Berry Moth.
Page 133, line 24 from bottom, *for* preceding insect *read* Grape Curculio.
Page 134, line 3 from bottom, *for* Part V *read* Part VI.

Page 142, under the heading, *add* (LEPIDOPTERA TORTRICIDÆ).
Page 150, line 26, *for* THYRIDOPTERYX *read* THYRIDOPTERIGIS.
Page 150, line 37, *for* ferruginuous *read* ferruginous.
Page 154, in the heading, for *zeas* read *zeæ*.
Page 155, line 13, *for* ZEAS *read* ZEÆ.
Page 161, line 38, *for* Trallien *read* Trallian.
Page 166, under heading, *add* (LEPIDOPTERA, PYRALIDÆ).
Page 171, line 3 from bottom, *for* transformation *read* transformations.
Page 173, line 3 from bottom, *for* it *read* the more liquid parts.
Page 174, line 3 from bottom, for *Solidaga* read *Solidago*.
Page 175, line 32, *add* front *before* wing.
Page 176, line 21, *for* through *read* into.
Page 177, line 26, *strike out* in.
Page 177, line 13, after *coxæ* read *trochanters*.
Page 178, lines 2 and 3, *for* GELECHIA *read* GELECHIÆ.
Page 179, line 32, *for* assimilating *read* assimulating.
Page 179, in heading and line 12, for CHICKWEED read KNOTWEED.
Page 179, lines 12, 13, for (*Stellaria media*) read (*Polygonum aviculare*.)
Page 180, line 7, for *Cersium lanceolata* read *Cirsium lanceolatum*.

REPORT II.

Page 8, line 14 from bottom, *for* I have *read* has been.
Page 8, line 13, from bottom, *before* on *read* largely from Mr. Walsh's previous writings.
Page 13, line 25, *for* cupable *read* culpable.
Page 16, line 13, *for* lava *read* larva.
Page 23, line 6 from bottom, *for* hole *read* holes.
Page 32, line 17, *for* insect *read* insects.
Page 35, line 24, for *Corimelœna* read *Corimelæna*.
Page 40, line 23, for *Ophinsa* read *Ophiusa*.
Page 41, line 25, for *Laphrygma* read *Laphygma*.
Page 50, line 5 from bottom, for *leuca*[*i*]*æ* read *leucan*[*i*]*æ*.
Page 53, line 12, for *perpulcra* read *perpulchra*.
Page 56, line 7 from bottom, for *Salanum* read *Solanum*.
Page 58, line 19, for *copalina* read *copallina*.
Page 59, line 9 from bottom, *for* varigated *read* variegated.
Page 76, line 4 from bottom, *for* I *read* V.
Page 76, line 5 from bottom, for *Daphni* read *Daphne*.
Page 82, line 25, *for* one *read* our.
Page 92, line 3, *for* 125–131 *read* 129–131.
Page 107, line 12, for *Naturalista* read *Naturaliste*.
Page 111, line 34, for *crysalis* read *chrysalis*.
Page 116, line 4 from bottom, *for* month *read* molt.
Page 118, line 2, *for* carved *read* curved.

REPORT III.

Page 6, line 3 from bottom, *for* Rosa *read* Rose; and for *rosa* read *rosæ*.
Page 7, line 31, for *Hyleœctus* read *Hylecœtus*.
Page 25, line 8 from bottom, *for* finely *read* finally.
Page 28, line 3 from bottom, *for* Holmgreu's *read* Holmgren's.
Page 30, line 16, *for* thc *read* the.
Page 30, line 16, *for* characterize *read* distinguish.
Page 47, line 3, *for* Feunde *read* Feinde.
Page 55, line 50, *for* that *read* than.
Page 57, line 18 from bottom, add *c* before the first *h*.
Page 58, line 3 from bottom, for *fornudolosus* read *formidolosus*.

Page 64, line 19, for *Bignonio* read *Bignonia.*
Page 78, note, *for* I *read* II.
Page 95, line 26, *for* belongs *read* belonging.
Page 117, line 5 from bottom, *for* Harr. *read* Fabr.
Page 123, last line, *for* an *read* and.
Page 129, lines 12 and 17, for *Colosoma* and *Calosoma.*
Page 131, line 13 from bottom, *for* fauns *read* fauna.
Page 135, line 33, *for* dints *read* dents; and line 21, for *a* read *b.*
Page 136, line 22, *for* Guenèe *read* Guenée.
Page 136, line 33, *for* Furtsenthum Walldeck *read* Fürstenthum Waldeck.
Page 145, line 35, *strike out second* the.
Page 146, line 24, *add* s *to* transformation.
Page 150, line 14, at end, *add* from an.
Page 151, line 12, for *Cnythia* read *Cynthia.*
Page 166, line 16 from bottom, strike out first comma.
Page 166, line 6 from bottom, for *phalangea* read *phalanga.*
Page 169, line 33, for first *i* read *e.*
Page 170, line 10, *for* Nnaural *read* natural.

REPORT IV.

Page 6, first verse, *for* grow *read* grows.
Page 19, line 8, *for* 5 *read* 6.
Page 20, last line but one, *for* R *read* U.
Page 22, last line but one, for *Aleochora* read *Aleochara.*
Page 40, line 9 from bottom, *for* occular *read* ocular.
Page 41, line 59, *for* Vt. *read* Ct.
Page 41, line 15 from bottom, *after "Larva" read* Length 0.5 inch.
Page 42, line 5, *add a comma after* Lepidoptera.
Page 43, line 6 from bottom, *for* claud *read* cloud.
Page 46, line 29, *for* edgae *read* edge.
Page 46, line under heading, *add a comma after* Lepidoptera.
Page 47, line 30, *for* rhomboidally *read* trapezoidally.
Page 53, line 25, and page 54, line 27, for *basillare* read *basilare.*
Page 53, *strike out all after* for many *in the note.*
Page 59, line 10 from bottom, *add* winged *before* female.
Page 67, line 4 from bottom, for *Cordifolia* read *Riparia.*
Page 68, line 2 from bottom, for *Oid* read *Oil.*
Page 75, third line in heading, *add a comma after* Lepidoptera.
Page 103, third line of note, *for* insest *read* insert.
Page 105, line 8 from bottom, *for* chrysallis *read* chrysalis.
Page 110, line 3, for CHALSIS read CHALCIS.
Page 110, line 29, for *extramatis* read *extrematis.*
Page 112, in the heading, *for* Hübn *read* Drury.
Page 132, line 19, *for* Chesnut *read* Chestnut.
Page 137, line 1, *for* Pernyi Silkworm *read* Perny Silkworm.
Page 137, under fig. 60, *for* Pernyi *read* Perny.

REPORT V.

Page 7, line 22, *for* stage *read* state.
Page 7, second line from bottom, *strike out second* the.
Page 8, explanation of Fig. 1, first line, *for* and *read* the.
Page 9, under Fig. 2, for BEMBEX FASCIATA read VESPA MACULATA.
Page 9, line 11, *for last* and *read* with the.
Page 11, line 9 from bottom, *after* worm *add* moth.
Page 11, line 3, from bottom, *for* four *read* eight.
Page 12, line 24, *for ἑτεροῖς read ἕτερος.*

Page 12, Fig. 5, for EUSCHISTES read EUSCHISTUS.
Page 13, line 3 from bottom, *for* larvæ are *read* larva is.
Page 14, under Fig. 8, for ŒDIPODA DIFFERENTIALE read CALOPTENUS DIFFERENTIALIS.
Page 18, line 10 from bottom, *for* pollenation *read* pollination.
Page 19, line 30, for *Lymexilon* read *Lymexylon*.
Page 21, line 8 from bottom, *for* Townsend *read* Townend.
Page 24, line 13, *for* ærial *read* aërial.
Page 33, in Fig. 15, *for* cloroform *read* chloroform.
Page 43, line 6 from bottom, *after* or *add* in.
Page 51, line 17, *for* J. S *read* S. J.
Page 56, line 24, *for* how *read* that.
Page 52, line 21, for *peteolaris* read *petiolaris*.
Page 58, line 16 from bottom, *for* decrepid *read* decrepit.
Page 61, line 18, *for* hypertrophized *read* hypertrophied.
Page 66, line 13, for *Cordifolio* read *Cordifolia*.
Page 67, line 27, *for* with *read* to.
Page 67, line 28, *after* and *add* to offer.
Page 83, line 13 from bottom, *for* who *read* as.
Page 85, line 17 from bottom, *after* fecundation *add* either the.
Page 85, line 18 from bottom, *strike out* either *and after female add* would.
Page 86, line 2 from bottom, for *and* read *und*.
Page 90, line 17, *for* had *read* has.
Page 100, last line, add a comma *before* say.
Page 101, line 10, for *nole* read *noli*.
Page 103, line 9, for *Caryœ* read *caryœ*.
Page 113, line 40, *for* 19 *read* 41.
Page 115, *for* exerted *read* exserted.
Page 120, line 25, *for* regulary *read* regularly.
Page 126, line 4 in note, for *querciti* read *querceti*.
Page 126, line 5 in note, for *pithicium* read *pithecium*.
Page 129, line 14, *omit* color of the.
Page 139, *for* Papineau *read* Popenoe.
Pages 140 and 141, wherever *Belvosia* occurs read *Belvoisia*.
Page 156, line 6, *for* consumes *read* has consumed.

REPORT VI.

Page 8, last line, *for* 1874 *read* 1873.
Page 12, line 13, for *Sisimbrium* read *Sisymbrium*.
Page 12, line 25, for *osciamus* read *oscyamus*.
Page 12, lines 13, 14, for *Poligonum* read *Polygonum*.
Page 27, line 2 from bottom, for *pesorus* read *pecoris*.
Page 27, line 15 from bottom, for *vireus* read *virens*.
Page 28, last line, for XV read XVI.
Page 35, line 3, *for* three *read* four.
Page 37, line 16, *for first* by *read* be.
Page 42, line 11, *for* the *read* certain.
Page 43, line 26, *strike out* to be presently treated of.
Page 47, remove "Telegraph" from "Summer grape" § to that of "Northern Fox."
Page 51, line 7 from bottom, for *insidious* read *insidiosus*.
Page 53, line 18, *for* Maguin *read* Mégnin.
Page 82, line 5 from bottom, *for* New *read* West.
Page 87, line 3 from bottom, for *Bignonio* read *Bignonia*.
Page 92, line 6, for *Callimorpa* read *Callimorpha*.
Page 94, line 14 from bottom, *for* point *read* joint.
Page 100, line 31, omit comma after *lardarius*.

Page 108, line 28, *for* orage *read* orange.
Page 111, line 6, for *perspicillata* read *tripunctata.*
Page 118, last line, for *Phytopoga* read *Phytophaga.*
Page 136, line 15, *for* Rosel von Rösenhof *read* Rösel von Rosenhof.
Page 141, line 9, *after* found *add* that.
Page 150, line 9, *for* pictures of *read* imprints on.
Page 154, line 6, strike out †.
Page 154, line 16, *for* it is *read* they are.
Page 156, line 8, *after* and *add* more.
Page 162, line 10, *for* elytram *read* elytrum.

REPORT VII.

Page IV, line 9, *for* contemptibly *read* contemptuously.
Page 1, line 10, *after* and *read* invaded the.
Page 5, line 16, *for* State *read* state.
Page 7, line 7, *for* calubrine *read* colubrine.
Page 11, line 32, *for* stoma *read* stomata.
Page 11, line 33, *for* dilutent *read* diluent.
Page 11, line 37, for J read S.
Page 12, line 13, for W. K read R. C.
Page 17, last line, for *Dep. de l'Hèrault* read *Dép. de l'Hérault.*
Page 21, line 14 from bottom, for LENCOPTERUS read LEUCOPTERUS.
Page 39, under Fig. 6, for TTIM read TRIM.
Page 52, line 14, *for* McWallie read McNallie.
Page 52, line 46, *for* Princeton read Purinton.
Page 75, line 32, *for* breed *read* bred.
Page 80, line 7 from bottom, add a comma before and after *pometaria.*
Page 81, last line, *for* nidi *read* nidus.
Page 94, in the sub-head, for GALL-INHABITING read ROOT-INHABITING.
Page 99, line 7, in note, *for* nerves *read* tracheæ.
Page 108, line 17, *for* two *read* too.
Page 117, line 15, *for* V *read* IV.
Page 118, line 17 from bottom, *for* hight *read* height.
Page 147, line 20, *for* 1873 *read* 1866.
Page 162, line 20, *for* larva *read* lava.

REPORT VIII.

Page III, line 13 from bottom, add 1 before the 3.
Page 7, line 26, *for* copper *read* soda.
Page 22, in notes, transpose the * and †.
Page 34, line 6, for *tuliètes* read *tuélites.*
Page 34, line 11, *for* three-hundredths *read* two-hundredths.
Page 37, under Fig. 23, *for* exerted *read* exserted.
Page 38, line 6, *for* glass *read* grass.
Page 52, line 1 in note, for *Dolicønyx* read *Dolichonyx*, and for *orizivora* read *oryzivora.*
Page 53, line 32, for *veridascens* read *viridascens.*
Page 98, second line, in explanation of Fig., for *e* read *c* and for *c* read *e.*
Page 100, line 2, *after* they *add* are still imperceptible; in the third stage (after second molt) they.
Page 100, line 4, *for* third *read* fourth, and *for* second *read* third.
Page 100, line 7, *for* fourth *read* fifth, and *for* third *read* fourth.
Page 100, line 8, *for* fourth *read* fifth and *for* fifth *read* sixth.
Page 114, line 7 from bottom, *for* distingulsh *read* distinguish.

Page 115, line 5, *after* histories *add* a comma.
Page 115, line 5 from bottom, for *Pesotettix* read *Pezotettix.*
Page 121, line 18, *after* limbs *add* and.
Page 149, under Fig. 46, *for* larva *read* pupa.
Page 150, line 10, for *gran* read *granu.*
Page 154, line 4 from bottom, *for* sheli *read* shell.

REPORT IX.

Page 6, line 26, insert after "moth" (*Euphanessa mendica,* Walk.).
Page 15, line 3, *for* entite *read* entire.
Page 29, in explanation of cut, *for* Abbott's *read* Abbot's.
Page 50, explanation of cut, for *e* read *c.*
Page 50, line 3 from bottom, *for* Hubner *read* Hübner.
Page 54, last line, in place of the comma, *write* is.
Page 55, line 1, *for* the other *read* the second.
Page 55, line 9 from bottom, *for* m. m *read* mm.
Page 55, line 7 from bottom, *strike out the* on.
Page 56, line 1, *for* m. m *read* mm.
Page 56, line 2, *for the last* and *read* anal.
Page 56, line 32, commence a new ¶ with "Chrysalis" and italicize it.
Page 57, in the heading for *Spretus* read *spretus.*
Page 58, line 14, *strike out* have.
Page 87, strike out the *g* in line 17 and also in figure.
Page 89, line 13, *strike out the* i *after* embryon.
Page 90, last line, for *ambion* read *amnion.*
Page 98, line 11 from bottom, for *Compoplex* read *Campoplex.*
Page 98, line 6, *add a comma before* De Geer.
Page 98, note *, for *Bastardii* read *Bastardi.*
Page 98, under Fig. 28, for BASTARDII read BASTARDI.

NOTES AND ADDITIONS.

Under this head it is not my purpose to publish the many additional notes of observations which have been made by myself and others on the various insects treated of in the reports; but rather to indicate a few of the more important facts, especially such as are unpublished and bear on life-histories left incomplete. As, in preparing the reports, the older and better known generic nomenclature was almost uniformly employed, it is thought advisable to indicate in this bulletin the more recent nomenclature, and this is accordingly done either in these "Notes" or in connection with the reproduced "Descriptions of New Species" which follow:

HYMENOPTERA.

STIZUS GRANDIS Say (Rep. I, p. 27, Fig. 12)—This has been shown by Mr. W. H. Patton (Bull. U. S. Geol.-Geog. Survey, vol. V, p. 342) to be only a variety of *speciosus* Drury, which is the type of the genus *Sphecius* Dahlb.

CRYPTUS EXTREMATIS Cress. (Rep. IV, p. 111)—The questions in regard to the character of *C. samiae* Pack. have been settled by Dr. Hagen from an examination of the types (Bull. Buff. Soc. Nat. Sci., II, 206; 1875) confirming the conclusion which I came to. In Bulletin No. 3 of the Commission (p. 47) I have suggested that *extrematis* should sink as a synonym of *samiæ*, because two species (one of which is *nuncius*) were combined under it in the original description.

MICROGASTER MILITARIS Walsh (Rep. I, p. 89 and subsequently)—This is an *Apanteles* (See my Notes on N. A. Microgasters, etc. (Extr. from Trans. St. Louis Ac. Sc. IV), p. 19.)

ANTIGASTER MIRABILIS Walsh (Rep. VI, p. 162)—Mr. L. O. Howard has shown (*Can. Ent.* October, 1880. p. 209, and February, 1881, p. 31) that the habit of rolling back is not uncommon in the *Eupelmides*, and that *Antigaster* cannot well be separated from *Eupelmus* as at present understood.

COLEOPTERA.

CARABID LARVÆ (Rep. IX, p. 97)—The second larva mentioned on this page was subsequently reared by me to the perfect state and proved to be *Amara obesa* Say. It will be found figured and described in the First Report of the Commission (p. 290).

LEBIA GRANDIS, Hentz (Rep. III, p. 100)—This belongs to Chaudoir's genus *Loxopeza*.

LEBIA ATRIVENTRIS Say (Rep. VIII, p. 3)—Belongs to Chaudoir's genus *Loxopeza*.

HIPPODAMIA MACULATA, DeGeer (Rep. I, p. 112 and subsequently)—Now referred to Mulsant's genus *Megilla*. It does not appear that this species occurs also in Europe as stated in the text.

COCCINELLA MUNDA Say (Rep. II, p. 25)—This is now considered synonymous with *Cycloneda sanguinea* Linn.

COCCINELLA PICTA Randall (Rep. V, p. 101)—Now known as *Harmonia picta*.

MYSIA 15-PUNCTATA, Oliv. (Rep. IV, p. 18)—This has been referred to the genus *Anatis*, Mulsant.

LACHNOSTERA QUERCINA, Knoch. (Rep. 1, p. 156)—This is synonymous with *fusca* Fröhlich, which has priority. The fungus affecting it (p. 158 and Rep. 6, p. 125) is *Cordyceps ravenelii* Berkeley. (See *American Entomologist*, III, p. 139.)

CHAULIOGNATHUS PENNSYLVANICUS, De Geer (Rep. I, p. 57 and subsequently)—This is now known as *Ch. americanus* Forst., the latter name having priority. For an account of the eggs and young larvæ, see Second Report of the Commission, p. 261.

SAPERDA BIVITTATA Say (Rep. I, p. 42)—This is now admitted to be a synonym of *candida* Fabr. For a correct description of the eggs and mode of oviposition, see an article by me in New York Weekly *Tribune*, Feb. 20, 1878.

BRUCHUS PISI Linn. (Rep. III, p. 44)—This name of the 12th edition of Linnaeus's "Systema Naturæ" gives way in modern catalogues to *pisorum* L. of the 10th edition.

FIDIA VITICIDA Walsh (Rep. I, p. 32)—This species is not mentioned by Crotch in his "Materials for the Study of the Phytophaga of the U. S." (Proc. Ac. Nat. Sc. Phil., 1873), but his *Fidia murina* (l. c. p. 33) is undoubtedly synonymous with Walsh's *viticida*, the latter name having priority by several years. In Crotch's "Check list" this species is also omitted, but the *Fidia vitis* Walsh in the "Omissions" to that list (p. 127) is probably meant for *viticida*.

HALTICA CHALYBEA, Illiger (Rep. III, p. 79)—This belongs to the genus *Graptodera* Chevr.

HALTICA CUCUMERIS Harris (Rep. I, p. 101)—This is now referred to the genus *Epitrix*, Foudras.

PHYSONOTA QUINQUEPUNCTATA Walsh & Riley (Rep. II, p. 59)—This is synonymous with *Ph. unipunctata* (Say), there being no question as to the specific identity of the two, both having been bred by Mr. F. H. Chittenden, of Ithaca, N. Y., from larvæ on a wild sun-flower (*Helianthus*).

CASSIDA NIGRIPES Oliv. (Rep. II, p. 63)—The eggs of this species are much like those of *aurichalcea* (Rep. II, Fig. 31) in size, form and color, though the spine-like appendages break off more easily. They may, however, be distinguished by being larger (1.6^{mm} long without projections), having, in fact, nearly double the bulk, and by the flat posteriorly projecting piece which bears the spine-like appendages being generally greatly developed so as sometimes to extend beyond the apex fully one-third the length of the whole egg. Sometimes this piece divides distinctly into three spines, but in other cases it is quite blunt.

CASSIDA BIVITTATA Say (Rep. II, p. 61)—The eggs of this species are pale and ovoid, just 1^{mm} long, but invariably covered with a yellowish secretion which dries and spreads out each side, and this by a black excrementitious material which gives the egg from above the appearance of an ovoid bit of excrement flattened on the adhering side. The eggs are laid singly or in twos or threes.

CASSIDA AURICHALCEA Fabr. (Rep. II, p. 62)—This is now referred to the genus *Coptocycla* Chevr.

CASSIDA PALLIDA Herbst (Rep. II p. 62)—This is now recognized as a synonym of *Coptocycla aurichalcea* (Fabr.).

COPTOCYCLA GUTTATA, Oliv. (Rep. II, p. 63)—The eggs of this species, which I have often since observed, are deposited singly or in twos, threes or fours. They are rather more than 1^{mm} long, of the same general form and character as those of *Cassida bivittata*, but more narrow and elongate. The color is pale yellowish and translucent. The egg is always covered with a viscid fluid which dries to form a transparent covering verging to fulvous or gamboge in color. This covering almost always spreads out on each side of the egg in ray-like ridges, those on each side parallel and slightly oblique, and whenever the egg is single these ridges are remarkably regular and have a neat appearance. There is occasionally on the top of this a varying amount of ex-

crement. The structure of the covering is similar to that found in the egg of *Cassida texana* Cr. (which feeds on *Solanum eleagnifolium*), where, however, the ribs are finer and transverse, and there is no excrementitious covering. The newly hatched larva of *guttata*, like that of the other species is whitish, strongly recalling in general appearance an ordinary mite, the head not being concealed as it subsequently is, the hairs at the tip of the legs being frequently clavate or knobbed, and resembling those on the young of many Coccids. The marginal spines and the anal fork are quite well developed but simpler than in the subsequent larval stages. This newly hatched larva is quite nimble and crawls easily over glass.

Deloyala clavata, Oliv. (Rep. II, p. 56)—Now referred to the genus *Coptocycla*.

Blister-beetles (Rep. 1, p. 96 *ff.*)—The larvæ feed on locust eggs. For account of their larval economy see my paper "On the larval Characters and Habits of the Blister-beetles," etc., Trans. Ac. Sc. St. Louis III, p. 544 ff.: also Reports of the Commission I, p. 292 ff.; II, 262 ff. Remarks on synonymy are also there given, but the following may be repeated.

Lytta cinerea Fabr. (Rep. I, p. 97)—This is now known as *Macrobasis unicolor* (Kirby).

Lytta murina Lec. (Rep. I, p. 98)—This is a color variety of *Macrobasis unicolor*.

Lytta marginata Fabr. (Rep. I, p. 98)—This is believed by Horn to be a color-variety of *Epicauta cinerea* (Forst.).

Lytta atrata Fabr. (Rep. I, p. 98)—This is the *Epicauta pensylvanica* (De Geer) of Crotch's List.

Anthonomus prunicida, Walsh. (Rep. III, p. 39)—Upon this species, which is a synonym of *scutellaris* Lec., Dr. Leconte has since founded the genus *Coccotorus* (Proc. Am. Philos. Soc. vol. XV, 1876, p. 193).

Conotrachelus nenuphar, Hbst. (Rep. III, p. 127, note)—The phytophagic variety of this species from Walnut and Butternut has since been characterized by Dr. Leconte as a distinct species, *C. juglandis* (Proc. Am. Philos. Soc. vol. XV, p. 226).

Cœliodes inæqualis, Say (Rep. I, p. 128)—Dr. Leconte has since founded upon this species the genus *Craponius* (Proc. Am. Philos. Soc. vol. XV, 1876, p. 268). The egg of this snout-beetle is quite large, bright yellow in color and deposited in a cavity half as large as the beetle, though the puncture leading to it is small. The lateral angularities or tubercles of the joints, as described by Walsh, are quite characteristic, and the dorsal view in my figure, given to show them, conveys a somewhat false impression of the larva, which is more or less curved, and has the general characteristics of Curculionid larvæ. The figure is rather more attenuated than it should be. That the beetle hibernates I have since proved beyond question.

Baridius trinotatus Say (Rep. I, p. 93)—Dr. Leconte (Proc. Am. Philos. Soc. XV, 1876, p. 287) has since established for this and two allied species the genus *Trichobaris*.

Sphenophorus zeæ Walsh (Rep. III, p. 59)—This has been previously described by Mr. Uhler as *S. sculptilis* (Proc. Ac. Phil. VII, 1855, p. 416).

Sphenophorus pulchellus Schœnherr (Rep. III, p. 60)—As intimated in the footnote on the same page, this species is synonymous with Say's *S. 13-punctatus*, for which species and for *Sphenophorus pustulosus* Gyllh. Dr. Leconte has established the genus *Rhodobœnus* (Proc. Am. Philos. Soc. vol. XV, 1876, p. 332). I have reared both, and also intermediate forms, from Helianthus in Texas, and Ambrosia in Missouri.

Scolytus caryæ Riley (Rep. V, p. 107)—Dr. Leconte (Proc. Am. Phil. Soc. XV, 1876, p. 371) has since decided that 4-*spinosus* Say is the ♂ of this species, and Say's name consequently obtains.

LEPIDOPTERA.

Papilio philenor Drury (Rep. II, p. 116)—Referred by Scudder to Hübner's genus *Laërtias*. For further notes and description of the egg and young larva, see *Canadian Entomologist*, January, 1881, p. 9, and *American Naturalist*, April, 1881, p. 327.

DANAIS ARCHIPPUS, Fabr. (Rep. III, p. 143)—For further facts respecting the swarming and migrations of this butterfly, see the *American Entomologist* (III, p 101), and for a fuller and more accurate account of the mode of pupation, see my paper on the "Philosophy of the Pupation of Butterflies and particularly of the Nymphalidæ" (Proc. Am. Ass. Adv. Sc. vol. XXVIII, 1880).

ÆGERIA ACERNI, Clem. (Rep. VI, p. 110)—Mr. D. S. Kellicott has an interesting article in the *Canadian Entomologist* for January, 1881, on the Ægerians inhabiting the vicinity of Buffalo, N. Y., in which he states that the chrysalis of this species in his locality does not agree with my description as "unarmed," if that description refers to the dorso-abdominal teeth. A reëxamination of my specimens shows that my statement applies to the absence of these teeth. It is, however, possible that there is some variation in this regard and that the eastern specimens from the Hard maple differ from the western ones from the Soft maple in having the teeth as indicated by Mr. Kellicott.

ARCTIA ISABELLA, Smith (Rep. IV, p. 143)—Referred to *Pyrrharctia* Packard. For further account of larval variation and parasites, see *American Entomologist*, III, p. 134 (June, 1880).

HYPHANTRIA TEXTOR Harr. (Rep. III, 130)—There is no doubt in my mind, from frequent breeding of specimens, that this is synonymous with *cunea* Drury and *punctata* Fitch, which are but varieties, Drury's name having priority.

CALLIMORPHA FULVICOSTA, Clem. (Rep. III, 132)—Grote and Robinson give the synonymy of this species in their "List of Lepidoptera of N. A.," etc., *lecontei* Boisd. having priority. The late Jacob Boll bred all the forms from larvæ feeding on the same species of plant.

SAMIA COLUMBIA Smith (Rep. IV, p. 107)—Mr. Herman Strecker has given a beautiful figure of the male of this species in his "Lepidoptera Rhopaloceres and Heteroceres, etc.," 1875 (Pl. XII, Fig. 3), and Mr. F. B. Caulfield has described and figured the larva (*Canadian Entomologist*, X, p. 41, 1878) showing that it is structurally identical with that of *cecropia* and differs only in the intenser green of the body, in the lateral tubercles and bases of the others being white instead of pale blue and in the upper thoracic tubercles being of a deeper coral-red. It accords more with the *cecropia* larva in the fourth stage. It is placed as a good species in Grote's "List of N. A. Platypterices," etc. (Am. Phil. Soc., 1874), but I am still of opinion that it should not be considered a distinct species but simply a well-marked local color-variety worthy of name. There is great variation in color, whether of the larva, cocoon or imago, in *cecropia*.

CALLOSAMIA ANGULIFERA, Walker (Rep. IV, p. 122, note)—This is still considered a good species by systematists. Mr. Jno. Akhurst, of Brooklyn, N. Y., informs me that he finds it rather constant from larvæ which seem to differ in no respect from those of *promethea*, but which feed on the Tulip tree (*Liriodendron tulipifera*), and make the cocoon near the ground without pedicel. I learn from Dr. Packard that Mr. Uhler has bred both it and *promethia* from the same lot of larvæ.

CLISIOCAMPA SYLVATICA Harr. (Rep. III, 121)—This is now referred to *disstria* Hübn., which has priority.

AGROTIS INERMIS Harr. (Rep. I, p. 72)—This is now recognized to be identical with the European *A. saucia* Treitschke.

NOCTUA CLANDESTINA Harr. (Rep. I, p 79)—An *Agrotis*.

AGROTIS TELIFERA Harr. (Rep. I, p. 80)—This is now recognized as the European *A. ypsilon* Hüfn. = *A. suffusa* (S. V.) = *A. ortonii* Pack.

AGROTIS SUBGOTHICA Harr. (Rep. I, p. 81)—The moth represented under this name at Fig. 29, *a*, has since been described by Grote as *A. herilis*, and that at Fig. 29, *b*, has since been described by Lintner as *A. tricosa*. (Notes on some N. Y. Noctuidæ, Ent. Cont. III in Rep. N. Y. St. Mus. Nat. Hist., 1872, p. 159.)

AGROTIS JACULIFERA Guen. (Rep. I, p. 82)—This is the true *subgothica* of Haw. (See Grote, List of Noctuidæ of N. A., Bulletin Buffalo Soc. Nat. Sc. II, 1874, and Lintner *l. c.*)

AGROTIS DEVASTATOR, Brace (Rep. I, p. 83)—Grote refers it to *Hadena.*

CELÆNA RENIGERA Stephens (Rep. I, p. 86)—Referred by Grote to *Hadena.* Specimens in the Fitch collection marked with names (evidently from Walker) *infecta, egens, defectua, subcadens* ? and *murcimaculata* seem to be all synonyms and mere variations.

PRODENIA AUTUMNALIS Riley (Rep. III, p. 116 and subsequently)—As stated in the 8th Report (p. 48) this in the more typical form is recognized as *Laphygma frugiperda*, Sm. & Abb. The variety *obscura*, as Prof. Zeller, who has seen it, informs me is so near the European *exigua* Hübn. that it is not easily distinguished.

PRODENIA COMMELINÆ, Sm. & Abb. (Rep. I, p. 88, and III, p. 113)—Dr. Leon F. Harvey (Bull. Buff. Soc. Nat. Sci., vol. II, pp. 274, 275; 1875) has since proposed specific names for two of the forms hitherto considered to be but varieties of *commelinæ.* The moth represented at Fig. 48, *c*, of the Third Report, is named by him *flavimedia*, that at Fig. 48, *b*, *lineatella*, the true *commelinæ*, being a larger species. From larvæ with the series of black triangles bordered exteriorly by a yellow line (such as are represented on Plate I, Fig. 12 of Rep. I, and at Fig. 48 *a* of Rep. III) I have bred the *flavimedia.* But larvæ found on cotton in the Southern States, and differing in having black triangles on the second joint only, and also varying greatly in coloration, have produced the same moth. Abbot's figure of the larva of *commelinæ* shows the full series of black triangles, but without any yellow exterior line.

GORTYNA NITELA Guen. (Rep. I, p. 92)—I have proved by breeding that *G. nebris* Gn. is but a large, southern form of this species. In the Southern States it is most common in stems of *Ambrosia trifida*, often producing a swelling or pseudo-gall. Both forms are indiscriminately bred with intermediate variations. See an article by Miss E. A. Smith (7th Report on the insects of Illinois, Cyrus Thomas, pp. 112–114) for additional food-plants and the habit of the younger larvæ to infest wheat-stalks, corn, etc. See also Am. Ent. I, p. 252; my "Potato Pests" (Orange, Judd & Co., 1877, p. 91) and *Prairie Farmer*, August 11, 1877. The insect normally pupates in the stem and when infesting thin stalks like those of most cereals and blue-grass (in which it is also found) often of necessity leaves one stalk for another.

ANOMIS XYLINA, Say (Rep. II, p. 37; VI, 17)—This has since been referred by Grote to Hübner's *Aletia argillacea*, which has been generally adopted. See Bulletin 3 of the Commission on the Cotton Worm. While it will doubtless be found convenient in future to separate it from the other species of the genus *Anomis*, and Hübner's generic name may therefore obtain, I must confess, after a careful examination of Hübner's figure of *argillacea*, to grave doubts as to the correctness of Grote's reference thereto of our Cotton-worm Moth (*xylina*, Say). Hübner's figure lacks several of the most constant characteristics of *xylina.* It is fulvo-testaceous shaded with brown, with the under side bright yellow. It lacks the three white specks on primaries and has a dark (orbicular ?) spot in place of the outer one. It has a large white circular spot with black annulus in place of the dusky elongate discal spot with its double pupil. The wavy lines are almost black and differ in form; the fringes are unicolorous, and the abdomen is narrower. The figure more nearly represents in fact a species which I have received from Bahia, Brazil, and which differs from *xylina*, though the larva (also quite different) feeds on cotton.

We are all inclined to follow determinations of those who make a specialty of any group, but after due allowance for faulty coloring in Hübner's figure, I am constrained to believe that in this instance Mr. Grote has been in fault.

CANKER-WORMS (Rep. VIII, p. 12)—For additional remarks as to the generic characters of the two Canker-worms, see my paper "On the differences between *Anisopteryx pometaria* Harr. and *Anisopteryx æscularia* W. V., with remarks on the genus *Paleacrita.* (Trans. Ac. Sc. St. Louis, Vol. III, p. 573 ff.)

GALLEREA CEREANA, L. (Rep. I, p. 166)—This is the *mellonella* L. of the 10th edition Syst. Naturæ.

PEMPELIA GROSSULARIÆ Packard (Rep. I, p. 140)—The European *Zophodia convolutella* Hübn. (*Phycis grossulariella* Treitschke), which has precisely similar habits, closely resembles this species. In 1871 I compared it with this last in Mr. Stainton's collection and with specimens received from Prof. Zeller and could detect no essential differences. The European specimens are slightly larger, with broader wings and usually clearer, paler gray coloring. Colorational markings are, however, very variable in specimens from both sides of the Atlantic.

P. grossulariæ Packard was subsequently described by Grote as *Dakruma turbatella* (Bull. U. S. Geol.-Geog. Survey, IV, No. 3, p. 702; 1878). *Dakruma* seems to differ from *Zophodia* in nothing but the absence of the basal portion of the subcostal vein and possibly, although this character is not mentioned by Grote, in the recurved palpi. According to the synoptical table given by Heinemann, *grossulariæ* would fall in the genus *Stenoptycha*, distinguished from *Zophodia* by the recurved palpi. We may well question the generic value of this character, for different authors describe it quite differently: thus, Heinemann describes the palpi of *Stenoptycha* and *Homeosoma* as recurved, whereas Grote describes them as porrect in these two genera, if we accept his statement that *Honora* Grote is to be considered a section of *Stenoptycha*: there appears also to be a difference in position in specimens of the same species, according as the palpi are heavily scaled or have lost the scales. From the known individual variation in the venation of these and other moths, especially in the hind wings, we cannot attach any specific, much less any generic, value to the slight difference in the subcostal vein of *Dakruma* noted above. Moreover, authentic specimens of *grossulariæ* do not appear to possess this character of *Dakruma*. I am, therefore, of opinion that a study of sufficient material from both continents will prove the two specifically identical, or at the most that our American insect is a variety, and that *Dakruma* will not obtain. Packard is of this opinion, as in the later editions of his *Guide* the species is called *Myelois convolutella*.

PENTHINA VITIVORANA Packard (Rep. I, p. 133)—This is identical with a European insect having the same habits. It was first described over a century since by Schiffermiller & Denis as *Tortrix botrana*, and has been referred to various genera since, and finally to *Eudemis* Hübn., so that the insect should be known as *Eudemis botrana* (Schiff.). *Conchylis ambiguella* (Hübn.) has very similar habits in Europe. See Nördlinger's "Die Kleinen Feinde der Landwirthschaft," p 424 ff. It is the *Lobesia botrana* of the later editions of Packard's *Guide*.

EURYPTYCHIA SALIGNEANA Clem. (Rep. II, 134).—This according to Prof. Fernald, who has seen the type, is the same as Clemens's *Hedya scudderiana* (Proc. Acad. Sci. Phila., 1860, p. 358), the description of which is very brief and presumably taken from a female. The genus *Euryptychia* (Proc. Ent. Soc. Phila. V, 140) is founded on the male, which has a broad fold extending to the middle of costa on the primaries and covering up a pencil of yellowish hairs. Zeller subsequently redescribed it as *Pædisca affusana* (Beiträge, etc., pt. III, p. 101 [307]). From a comparison of female specimens I am led to believe that this is the same species that is commonly known in Europe as *Spilonota roborana* Schiff., though in Staudinger and Wocke's Catalogue *cynosbana* Fabr., described in 1875, is given the priority and *aquana* Hübn. is placed as a synonym. The obliquity of the edge of the basal dark patch and the details of the ocellated spot upon which species have been separated, I find to be variable.

The insect in Europe is known to feed on the leaf-buds of the rose. I have abundant proof that in this country it is not a gall-maker, but, as was inferred in the Report, an inquiline. I have found its larva feeding upon the flowers as well as amid the terminal leaves of the Golden-rod, and have also found it in other galls. When feeding in the more exposed positions it generally has a carneous or rosy tint.

ANCHYLOPERA FRAGARIÆ W. & R. (Rep. I, 142)—This has been referred to *Phoxopteris comptana* Fröhl., and while the two very closely resemble each other Prof. Fernald informs me that he yet believes *fragariæ* to be distinct.

ŒTA COMPTA, Clem. (Rep. I, p. 151)—Notwithstanding Mr. Grote doubts the identity of this insect with Cramer's *Phalæna punctella*, there is no question in my mind about it, and I entirely agree with Zeller, who makes also the *Tinea pustulella* Fabr. a synonym (Beitr. z. Kenntn. N. A. Nachfalter II, p. 28). It was first described in this country in 1856 by Fitch as *Deiopeia aurea* (3rd Rep. Ins. N. Y., p. 168.) See also "Zygænidæ and Bombycidæ of N. A." by R. H. Stretch, 1872, pp. 159 and 241.

The egg of this insect is one of the most singular Lepidopterous eggs with which I am familiar. I have found it numerously in the South in midsummer. It is 0.9^{mm} long, soft and plastic so as to be variable in form; but when laid (as it often is) on the web which the young larvæ make, where it takes on the more natural form, it is ovoid, somewhat compressed, with frequently a median ridge and one end narrowed and produced into a short neck. The color is cream-yellow and the delicate shell is corrugulate. It is laid singly and generally slightly attached by the broad side to the side of the mid-rib of the tenderest leaves, and its contact (by virtue, doubtless, of some poisonous liquid with which it is laid) causes a well defined swelling of the leaf-vein.

The species is placed among the *Zygænidæ* in Grote and Robinson's *List*, and has evidently more affinities therewith than with the *Teneidæ*.

PRONUBA YUCCASELLA Riley (Rep. V, p. 150 and subsequently)—For further facts regarding this species, see my papers in Trans. St. Louis Ac. Sc. III, p. 568; *American Entomologist* III, pp. 141, 182, 293, and also a paper read before the American Association for the Advancement of Science at Boston, Aug., 1880, and to be published in the Proceedings of the Association for that year.

PTEROPHORUS PERISCELIDACTYLUS (Rep. III, p. 65)—This belongs to the genus *Oxyptilus*, Zeller.

HETEROPTERA.

ARMA SPINOSA Dallas (Rep. II, p. 113 and subsequently)—Now referred to Stål's genus *Podisus*.

EUSCHISTUS PUNCTIPES, Say (Rep. IV, p. 19 and subsequently)—This is now known as *Euschistus variolarius* Beauv., this last having priority over Say's name.

COREUS TRISTIS, De Geer (Rep. I, p. 113 and subsequently)—Belongs to Amyot & Serville's genus *Anasa*.

MICROPUS LEUCOPTERUS, Say (Rep. II, p. 15 and subsequently)—Now referred to Burmeister's genus *Blissus*.

ANTHOCORIS INSIDIOSUS, Say (Rep. II, p. 27 and subsequently)—Belongs to Fieber's genus *Triphleps*.

REDUVIUS RAPTATORIUS Say (Rep. I, p. 114)—Belongs to *Sinea*, Amyot & Serv., and is synonymous with *diadema* Fabr.

HARPACTOR CINCTUS Fabr. (Rep. I, p. 114 and subsequently)—Belongs to Stål's genus *Milyas*.

HOMOPTERA.

CICADA SEPTEMDECIM (Rep. I, p. 18)—This orthography, used in the Reports, is grammatically correct, but I find that Linnæus himself wrote *septendecim* (Systema Naturæ, Tom I, Pars II, 12th Ed. Stockholm 1767). Fitch used both forms of spelling, but Westwood, Harris and most other authors follow Linnæus, and *septendecim* is, therefore, preferable. As to whether the 17 and 13-year broods should be considered specifically distinct, I am still of the opinion expressed in the First Report that the insects should not be looked upon as distinct species, but that *tredecim* Riley should rather be considered a race, or as Walsh (in a letter to Charles Darwin, which has kindly been shown me by Mr. G. H. Darwin) puts it, an incipient species, to which, for convenience, it is desirable to give a distinctive name. That it may be looked upon as a good species by excellent authority, will be seen by Walsh's discussion of the subject (*American Entomologist* II, p. 335) which I here quote:

What candid entomologist, who has worked much upon any particular order, will not allow that there are certain genera where it is often or almost or quite impossible

to distinguish species by the mere comparison of cabinet specimens of the imago? Lœw and Osten Sacken have said this of the genus *Cecidomyia* in Diptera; Osten Sacken of two other Dipterous genera, *Sciara* and *Ceratopogon;* Norton of the genus *Nematus* in Hymenoptera; and Dr. Le Conte lately assured me that, although when he was a young man he thought himself able to discriminate, in the closet, between the different species of *Brachinus* in Coleoptera, he now considered it quite impracticable to do so with any degree of certainty. And yet who doubts the fact of the existence, in North America, of very numerous distinct species of *Cecidomyia*, of *Sciara*, of *Ceratopogon*, of *Nematus*, and of *Brachinus*.

Upon the same principle I strongly incline to believe that the 17-year form of the Periodical Cicada (*C. septemdecim*, Linn.) is a distinct species from the 13-year form (*C. tredecim*, Riley) although it has been impossible for me, on the closest examination of very numerous specimens, to detect any specific difference between these two forms.* It is very true that the 13-year form is confined to the more southerly regions of the United States, while the 17-year form is generally, but not universally, peculiar to the Northern States; whence it has been, with some show of plausibility, inferred that the 13-year form is nothing but the 17-year form accelerated in its metamorphosis by the influence of a hot southern climate. But as these two forms interlock and overlap each other in various localities, and as it frequently happens that particular broods of the two forms come out in the same year, we should certainly expect that, if the two forms belonged to the same species, they would occasionally intercross, whence would arise an intermediate variety having a periodic time of 14, 15 or 16 years. As this does not appear to have taken place, but, on the contrary, there is a pretty sharp dividing line between the habits of the two forms, without any intermediate grades of any consequence, I infer that the internal organization of the two forms must be distinct, although externally, when placed side by side, they are exactly alike. Otherwise, what possible reason could there be for one and the same species to lie underground in the larva state for nearly 17 years in one county, and in the next adjoining county to lie underground in the larva state for scarcely 13 years? I presume that even the most bigoted believer in the old theory of species would allow that, if it can once be proved to his satisfaction that two apparently identical forms are always structurally distinct, whether in their external or in their internal organization, they must necessarily be distinct species.

On the other hand, I firmly believe that many perfectly distinct forms, which at one time passed current, or which even now pass current, as true species, are in reality mere dimorphous forms of one and the same species. We find a good example of this in the dimorphous ♀ *Cynips, q. aciculata*, O. S., which has already been treated of at great length. We find another good example of the same thing in *Cicada Cassinii* ♂ ♀, Fisher, which is sufficiently distinct from the Periodical Cicada to have been classified as a distinct species, and yet never occurs except in the same year and in the same locality as this last, and what is more extraordinary still, is found not only along with the 17-year form (*C. septemdecim*), but also along with the 13-year form (*C. tredecim*).

Now, if *Cassinii* were a distinct species, and not, as I believe it to be, a mere dimorphous form of *C. septemdecim* and *C. tredecim*, the chances are more than a million millions to one against its always coinciding with the two other forms, not only as to the particular locality but as to the particular year of its appearance.

I do not know that any one has heretofore attempted to set at rest, by actual proof, the very general skepticism as to this insect remaining so long underground, on the part of those persons who have given little attention to the subject. I have been able to trace the development from year to year of my *tredecim* brood *XVIII* in the vicinity of Saint Louis by digging up the larvæ each year from 1868 to 1876, and noting the annual growth. They could always be found within from two to five feet of the surface upon the roots of trees, and had by the 8th year attained the first pupa stage, and I have no doubt but that, at this writing, the true pupæ are nearing the surface of the ground to appear in myriads in the perfect state in May and June of this year.

The fungus affecting this Cicada has since been described by Mr. C. H. Peck as *Massospora cicadina* (31st Rep. N. Y. State Mus. Nat. Hist., pp. 44, 1879).

ERIOSOMA PYRI, Fitch (Rep. I, p. 118) — After comparing specimens in Europe with our American insect, I have no doubt of the specific identity of the two, or of the root-inhabiting and twig-inhabiting forms. The insect should be known, therefore, as *Schizoneura lanigera* (Hausm.). See my remarks in *American Entomologist*, II, 359;

---

* For an excellent statement of the facts bearing upon this curious question, see a paper by Mr. Riley, the State Entomologist of Missouri, in No. 4 of the American Entomologist, and a still more complete one in his First Annual Report.

Rep. 3, p 95, and "Notes on Aphididæ of the U. S." (Hayden's Bull. U. S. Geol. & Geogr. Surv. of Terr., Vol. V, p. 3).

ASPIDIOTUS HARRISII Walsh (Rep. I, p. 7) — This belongs to Costa's genus *Diaspis*, and is apparently the species named *ostreæformis* by Curtis (Gardener's Chronicle, 1843, p. 805).

DIPTERA.

TRUPANEA APIVORA Fitch (Rep. I, p. 168; II, 122) — This has been renamed *Promachus Fitchii* by Osten Sacken (Cat. of the described Diptera of N. A. 2nd Ed., 1878, p. 234), the species proving different from *Bastardii* Lœw, and Fitch's name being preoccupied.

BEE-FLY LARVA (Rep. IX, p. 96) — The undetermined larva here illustrated (Fig. 24) has since proved to be that of a *Systœchus*, a genus of Bombyliid flies. For further details and determinations see the Second Report of the Commission (pp. 262–9).

SARCOPHAGA CARNARIA, L. (Rep. IX, p. 95) — The variety *sarraceniæ* of this species there mentioned is now considered a good species, for reasons stated in Bulletin 3 of the Commission (pp. 39, 40, note).

EXORISTA LEUCANIÆ, Kirkpatrick (Rep. II, p. 50 and subsequently) — Referred to the genus *Nemoræa* Desv. by Osten Sacken (Catalogue, etc., 1878, p. 150). The variety *cecropiæ* of this (Rep. IV, p. 108) is quoted by him as a distinct species under *Exorista*, probably a mistake caused by my employing the wrong figure in the *American Entomologist*, Vol. II, p. 101, where that of *E. flavicauda* is used for *leucaniæ*.

LYDELLA DORYPHORÆ Riley (Rep. I, p. 111)—Now included in the genus *Exorista*.

ORTHOPTERA.

ŒCANTHUS NIVEUS, De Geer (Rep. I, p. 138, and V, p. 120)—This species is common in all parts of the country, and I have proved, by breeding, that its eggs are those described and figured as such in the 5th Report. I agree with Scudder in considering *fasciatus* De Geer but a dark and rather well marked variety of it. Its chirp is intermittent, resembling a shrill *te-reat te-reat te-reat* with a slight pause between each. The eggs and punctures figured on page 119 of the 5th Report (Fig. 47) as probably those of *Orocharis saltator* are, as I have since proved by breeding and by watching the process of oviposition, those of a large species of Œcanthus, hitherto, I believe, very generally confounded with *niveus*, and which is described below as *Œ. latipennis* N. Sp. While *niveus* punctures all kinds of soft stems and pithy twigs, *latipennis* seems to prefer the more slender parts of the Grape-vine. The female, when she has sufficiently proceeded in the act of ovipositing, is so intent that she can very well be watched at night by the aid of a "bull's-eye."

The jaws are first used to slightly tear the outer bark. With the antennæ stretched straight forward and the abdomen bent up so as to bring the ovipositor at right angles with the cane, she then commences drilling, working the abdomen convulsively up and down about twice each second. The eggs, as described in the Report, are laid lengthwise in the pith, but always in two sets, one each side of the hole. The number varies according to the size of the cane, and the distance between the holes is also variable but usually less than in my figure. The hole is usually filled up with a white mucous secretion, though there is very little of it about the eggs. This secretion also doubtless serves to facilitate the drilling. The same female will lay over 200 eggs, and will sometimes puncture the same cane at intervals of ½ inch for 1½ feet or more.

The shrill of *latipennis* is continuous and recalls the trilling of a high-pitched dog-whistle in the distance. The key varies, however, and is sometimes much less high and more musical than at others. The commingled shrill of this species recalls also the distant croaking of frogs in spring. The broad wings are thoroughly elevated during the act or even bent forward, and the vibration is so rapid that there appears

to be no motion. The species, in addition to these differences in stridulation and habits, may be distinguished from *niveus* by the following characters:

ŒCANTHUS LATIPENNIS N. Sp.—White, the elytra of the ♀ sometimes grayish and the posterior femora in one specimen discolored. Antennæ immaculate, with the basal joints and the front of head usually roseate. Tip of ovipositor black. Pronotum as in *niveus*. Hind wings ♀ as long at the elytra or sometimes a trifle longer; of ♂ somewhat shorter than elytra. Elytra of ♀ irregularly reticulate between the parallel oblique veins, especially toward the base. Elytra of ♂ when unfolded $\frac{4}{5}$ as wide as long, the dorsal surface 14^{mm} to 16.5^{mm} long by 7^{mm} to 8^{mm} wide; the rasp 1.5^{mm} long and the teeth distinctly seen with a lens of low power. Ovipositor 6^{mm} long; subgenital plate broadly excavated. Claspers of ♂ with their tips broad, but slightly broader at base than at tip, not deeply separated.

Described from 15 ♂ ♀ specimens from Missouri, 1 ♂ from Alabama, and 1 ♂ from South Texas.

The form of the subgenital plate, the immaculate antennæ with their roseate base, and the larger size serve to distinguish the species as well in the pupa as in the imago state.

Œ. latipennis is a larger insect than *niveus* usually is. The ovipositor measures 6^{mm} in length, whereas in *niveus* it rarely exceeds 5^{mm} and in only one specimen, a sanguineous variety captured July 10, 1874, does it equal 6^{mm}. The male elytra of *niveus* in only one specimen, captured September 19, 1877, reach 13^{mm} in length by 6^{mm} in width on the upper face, and the size is generally much less. In *niveus* the unfolded male elytra are less than $\frac{2}{3}$, and usually only $\frac{1}{2}$, as wide as long, and the rasp is only 1^{mm} long, and the teeth are not so easily seen. The elytra of *niveus* female sometimes show an irregularity in the reticulation between the parallel oblique veins but never so great an irregularity as in *latipennis*, there being fewer cells. In only one specimen of *latipennis*, a male taken on cotton at Columbus, Tex., are there any black marks on the lower surface of the basal joints of the antennæ, representing the lines or dots which are always present in *niveus*. But the two species are most sharply separated by the form of the subgenital plate of the female, which in *niveus* narrows rapidly towards the tip which has a minute angular notch, and by the form of the male claspers, which in *niveus* have their tips very slender and parallel, being deeply parted, and then retreating rapidly from one another on each side.

Besides *niveus* there are recognized from North America three other species of *Œcanthus*, one of which, *californica* Sauss.,* recorded only from California, is described as having the posterior wings abortive.† The other two species, *nigricornis* Walk. from Illinois (description quoted in the *American Entomologist*, Vol. II, p. 207; 1870) and *varicornis* Walk. from Mexico, both described only in the female sex and differing from *niveus* in nothing but the slightly longer hind wings and the slightly greater size of the insect, and in *varicornis* having a slightly longer prothorax, have been retained as distinct species by Saussure. But *niveus*, as may be seen in a series of specimens, varies in these characters indefinitely, just as other species of crickets are admitted to vary; so we may consider Walker's species to be but varieties of *niveus*. They cannot be referred to *latipennis*, for in this species the wings rarely, and then but slightly, exceed the elytra.

One other North American species, *bipunctatus* DeG., has been referred to *Œcanthus*. It belongs, however, to the genus *Xabea* and should be known as *Xabea bipunctata* (DeG.).

As the female of *Xabea*‡ has not hitherto been described and Saussure did not recognize the genus as distinct from *Œcanthus*, it may be well to give here the characters drawn from both sexes to show how very clearly the two genera differ. The type of the genus is from Sumatra, and Walker, being unacquainted with our species, an Saussure,d having only imperfect specimens, both failed to recognize the existence of the genus in North America.

---

* Études sur les Orthoptères, (*in* Mission Scientifique au Mexique, etc. Recherches Zoologiques 6^{me} partie.) 3^{me} livraison; p. 462; 1874.

† By "abortive" is evidently meant, from the description following the diagnosis, simply shorter than abdomen. In this respect and in the male (which alone is described) being shorter than *niveus*, *californicus*, which I know only from the description, may most easily be distinguished.

‡ Walker, Cat. Derm. Salt. Brit. Mus., Pt. I, p. 109.

XABEA Walk.—First joint of antennæ armed with a stout, blunt tooth in front. Female elytra irregularly reticulated, the oblique longitudinal veins not being conspicuous; male elytra with the mediastinal vein strongly arcuated; no humeral angle. Wings twice as long as the elytra. Cerci only half as long as the abdomen, sinuous. Outer valves of the ovipositor ending in a single outwardly directed tooth which is preceded on the outside by a longitudinal series of three teeth; the inner valves compressed, ending in three teeth of which the middle one is much the longest. Posterior tibiæ with neither spurs nor serrations and having only 4 apical spurs, 2 within and 2 without; the first joint of posterior tarsi unarmed, the tarsi clearly but 3-jointed, the second joint short as in the other legs; tarsal claws with the inner tooth acute.

OROCHARIS SALTATOR Uhler (Rep. V, p. 119).—The eggs figured and described on page 119 as probably those of this insect are, as above stated, those of *Œcanthus latipennis.* I have, however, frequently obtained the eggs of the Orocharis since. In December, 1877, I watched a female ovipositing in the end of a dead and rather soft twig of the Soft-maple at Kirkwood, Mo. The twig had been pruned and the bark was somewhat gnawed by the cricket and the eggs thrust in irregularly from the end and from the sides. Both wood and pith were crammed with eggs, but all longitudinally inserted. The favorite nidus of the species is, however, the soft and somewhat corky, rough bark of the trunk and older branches of the American elm, the eggs being thrust in singly or in small batches, either longitudinally with, or very slightly obliquing from, the axis of trunk or branch. The female is very intent in the act, working her abdomen deliberately from side to side during the perforation. The ovipositor is held more obliquely than in *Œcanthus.*

The egg is amber-colored and very slender and elongate, the tip rather pointed and very faintly opaque with the surface but slightly granulate. It has scarcely any curve and varies from 3.5^{mm} to 4^{mm} in length and from 0.4^{mm} to 0.5^{mm} in diameter at middle.

The stridulation of this cricket is a rather soft and musical piping of not quite half a second's duration, with from 4 to 6 trills, but so rapid that they are lost in the distance. The key is very high, but varies in different individuals and according to moisture and temperature. It most resembles the vibrating touch of the finger on the rim of an ordinary tumbler when three-fourths filled with water—repeated at intervals of from 2 to 4 per second, and it may be very well likened to the piping of a young chick and of some tree frogs. As the species is very common in the Southwest its chirp is everywhere heard and is so distinctive that when once studied it is never lost amid the louder racket of the katydids and other night choristers. It is frequently heard during the day time in cloudy or damp weather, and I have heard it at Saint Louis the first days of November after a slight frost. The elytra in stridulating are raised less than in *Œcanthus* and are depressed at intervals.

The courting of the sexes is amusing. They face each other and play with their antennæ for the best part of an hour or more than an hour. The female is, otherwise, pretty quiet, but the male continually mouths the twig or the bark upon which the courting is being done, and plays his palpi at a great rate, very stealthily approaching nearer to his mate meanwhile. At last the antennal fencing ceases and those of the female bend back and then the male approaches until their heads touch. He then deliberately turns round, elevates the elytra and slips his abdomen under the female, who virtually mounts and assists him, his elytra overshadowing her head.

The eggs of this insect, as also those of *Œcanthus latipennis*, are devoured by a parasitic larva of similar form and size, and which I have not yet reared to the perfect state.

ORCHELIMUM GLABERIMUM, Burm. (Rep. V, p. 123)—The egg-punctures illustrated at Fig. 56 are, as there correctly supposed, those of this species, as I have since proved by watching the act of oviposition and by rearing from the eggs. The insect is very fond of using the tops of corn-stalks for the same purpose.

NEUROPTERA.

CORYDALUS CORNUTUS, L. (Rep. V, p. 141; IX, p. 125)—For additional facts relating to the early larval stages, see my notes on the "Larval Characteristics of Corydalus and Chauliodes and on the development of Corydalus cornutus (Proc. Am. Ass. Adv. Sc., 1878).

MITES.

TROMBIDIUM SERICEUM Say (Rep. VII, p. 175 and subsequently)—For the natural history of this species and the specific identity with it of the larval form known as *Astoma gryllaria* LeBaron, and for further facts respecting the other mites mentioned in the Report, see my remarks in the Transactions of the Academy of Science of Saint Louis, (Vol. III, p. cclxvii, October, 1877) in the *American Naturalist* for March, 1878, and in the First Report of the Commission (p. 306 ff.).

DESCRIPTIONS OF NEW SPECIES AND VARIETIES.

Some systematists have questioned whether descriptions of species in Agricultural Reports should be recognized. While my own views on this subject are pretty freely expressed on page 56 of my Third Missouri Report and elsewhere, the publication of this Bulletin affords a good opportunity to bring the descriptions that are scattered through the nine volumes together, with such notes on synonymy as present knowledge suggests, and such corrections as are given in the Errata. In the earlier reports the measurements were expressed in inches and hundredths of an inch, while in the later volumes the metric system was adopted as most convenient and accurate, and the measurements which follow have all been reduced to this standard. All changes of this character or other changes from the original are included in brackets, while the additional notes are in Long Primer type.

HYMENOPTERA.

PORIZON CONOTRACHELI, N. SP.—*Head* pitchy-black, opaque, the ocelli triangularly placed and close together; eyes oval, polished, and black; face covered with a silvery-white pubescence; labrum rufous, with yellowish hairs; mandibles and palpi, pale yellowish-brown; antennæ inserted in depressions between the eyes, reaching to metathorax when turned back, filiform, 24-jointed; black with basal joints 6–1 becoming more and more rufous, the bulbus always distinctly rufous; bulbus rather longer and twice as thick as joint 3; joint 2 about one-third as long. *Thorax* pitchy-black, opaque, the sides slightly pubescent with whitish hairs, the mesothorax rounded and bulging anteriorly, the scutellum slightly excavated and sharply defined by a carina each side; metathorax with the elevated lines well defined and running parallel and close together from scutellum to about one-fourth their length, then suddenly diverging and each forking about the middle. *Abdomen* glabrous, polished, very slender at base, gradually broader and much compressed from the sides at the apex which is truncated; peduncle uniform in diameter and as long as joints 2 and 3 together; joints 2–5 subequal in length; color rufous with the peduncle wholly, dorsum of joint 2, a lateral shade on joint 3, and more or less of the two apical joints superiorly, especially at their anterior edges, black; venter more yellowish: ovipositor about as long as abdomen, porrect when in use, curved upwards when at rest, rufous, with the sheaths longer and black. *Legs*, including trochanters and coxæ uniformly pale yellowish-brown with the tips of tarsi dusky. *Wings*, subhyaline and iridescent, with veins and stigma dark brown, the stigma quite large, and the two discoidal cells subequal and, as usual in this genus, joining end to end, but with the upper veins which separate them from the radial cell, slightly elbowed instead of being straight, thus giving the radial cell a quadrangular rather than a triangular appearance. ♂ differs from ♀ only in his somewhat smaller size and unarmed abdomen. Expanse ♀ 0.32 inch [= 8^{mm}], length of body, exclusive of ovipositor, 0.22 [= 5.5^{mm}]; expanse ♂ 0.28 [= 7^{mm}], length 0.18 [= 4.5^{mm}].

Described from 3 ♀ ♀, 1 ♂ bred May 26th–28th, 1870, from cocoons received from Dr.

I. P. Trimble, of New Jersey, and 1 ♀ subsequently received from the same gentleman—all obtained from larvæ of *Conotrachelus nenuphar*.

As I am informed by Mr. E. T. Cresson, of Philadelphia, who pays especial attention to the classification of the *Ichneumonidæ*, it might more properly be referred to Holmgren's genus *Thersilochus*, which differs from *Porizon* in the greater distance between the antennæ at base, and in the venation of the wing.—[Third Rept., p. 28, Fig. 9.

Limneria lophyri, N. Sp.—♀, length 0.30—0.35 inch [7.5—8.7^{mm}]. Head and thorax black with silvery white pile. Antennæ piceous, more than half as long as body; but slightly paler toward tip; bulbus either yellowish or rufous. Ocelli either rufous or black. Mandibles, palpi, front and middle coxæ trochanters and tibiæ, pale yellow. Tegulæ almost white. Abdomen, with faint pile, rufous, the petiole and sides of next joint usually blackish. Hind legs rufous, the base of tibiæ and of tarsi paler.

♂ somewhat smaller, and with more black on the abdomen.

Four ♂'s, 12 ♀'s bred from larvæ of *Lophyrus Abbotii*.—[Ninth Rept., p. 32.

Hemiteles (?) Cressonii, [N. Sp.]—♂—Length 0.25 [6^{mm}]. Black, opaque, head transversely-subquadrate; face clothed with pale glittering pubescence; spot on mandibles, palpi, scape of antennæ in front and the tegulæ, white; eyes large, ovate; antennæ longer than head and thorax, slender, black; thorax closely and minutely punctured; mesothorax with a deeply impressed line on each side anteriorly; scutellum convex, closely punctured, deeply excavated at base; metathorax coarsely sculptured, truncate and excavated behind, the elevated lines sharply defined, forming an irregularly shaped central area, and a triangular one on each side of it, the outer posterior angle of which is prominent and subacute; wings hyaline, iridescent, nervures blackish, stigma large, areolet incomplete, the outer nervure wanting; legs pale honey-yellow, coxæ paler, tips of posterior femora, and their tibiæ and tarsi entirely blackish; abdomen elongate ovate, flattened, petiolated, the first segment flat, gradually dilated posteriorly, somewhat shining, and indistinctly longitudinally aciculate; the two following segments opaque, indistinctly sculptured; remaining segments smooth and shining.—[First Rept., p. 177. Figured at Pl. II, Fig. 7.

Hemiteles (?) thyridopterigis, N. Sp.—♀ Length 0.36 [inch = 9^{mm}]; expanse 0.50 [inch = 12.5^{mm}]. Ferruginous, opaque. Head transverse, rather broader than thorax, the front much depressed; face prominent centrally beneath antennæ, closely punctured, thinly clothed with pale pubescence; clypeus and cheeks shining; tips of mandibles black; antennæ, long, slender, filiform, ferruginous, blackish at tips; thorax rugose; scutellum prominent, with sharp lateral margins; metathorax prominent, quadrate, abrupt laterally and posteriorly, finely reticulated and pubescent, the upper posterior angles produced on each side into a long, divergent, flattened, subacute spine; disk with two longitudinal carinæ, from which diverges a central transverse carina; tegulæ piceous; wings hyaline, subiridescent; a narrow, dark fuliginous band crosses the anterior pair a little before the middle, and a broad band of same color between middle and apex, this band having a median transverse hyaline streak; areolet wanting, second recurrent nervure straight, slightly oblique; apex of posterior wing fuscous; legs long and slender, ferruginous, more or less varied with fuscous; posterior coxæ, tips of their femora, and their tibiæ and tarsi, fuscous; base of four posterior tibiæ more or less whitish, forming a rather broad annulus on posterior pair; abdomen petiolated, subconvex, densely and finely sculptured, blackish, basal segment tinged with reddish, the second and third segments distinctly margined at tip with whitish; apical segments smooth and shining, thinly pubescent; ovipositor half as long as abdomen, sheaths blackish.

♂.—Not at all like the ♀. Length 0.33 [inch = 8^{mm}], expanse 0.44 [inch = 11^{mm}]. Long, slender, black, polished, without distinct punctures, thinly clothed with white pubescence; palpi white; antennæ long, slender; scape reddish; mesothorax gibbous, with two deeply impressed longitudinal lines; metathorax with well-defined elevated

lines, forming several irregular areas; sides rugulose, apex without spines or tubercles; tegulæ white; wings whitish-hyaline, subiridescent, the nervures and stigma white, subhyaline, neuration as in ♀; legs long, slender, pale honey-yellow; coxæ, posterior trochanters, apex of their femora, and their tibiæ and tarsi, blackish; base of posterior tibiæ with a white annulus; abdomen long, slender, flattened, petiolated, smooth and polished, the apical margin of second segment being narrowly whitish.

Described from four ♀ and one ♂ specimens bred from the same [Thyridopteryx] cocoon.—[First Rept. p. 150. Figured at Pl. II, Figs. 11, 12.

The species is quite common in Washington, D. C., and is often attacked by a secondary Chalcid parasite.

Microgaster limenitidis, N. Sp.—♂ ♀. Length 0.09 inch [$=2\frac{1}{4}^{mm}$]. Color pitchy-black. Antennæ black, about as long as body; palpi whitish. *Thorax* minutely punctured. *Abdomen* with the two or three basal joints emarginate and rugose, the terminal joints smooth and polished. *Legs* dusky; front and middle femora yellowish, hind femora black; front and middle tibiæ yellowish, hind tibiæ with terminal half dusky, but the spur pale; front and middle tarsi yellowish tipped with dusky, hind tarsi dusky above, paler below. *Wings* hyaline, iridescent, the nervures and stigma black or dark-brown, the radial nervule, the cubital nervules and the exterior nervule of the discoidal cell, sub-obsolete.

Described from 6 ♀, 1 ♂, bred from larvæ of *Limenitis disippus*.—[Third Rept., pp. 158, 159.

The specimens referred to in connection with this description as bred from *Gelechia gallæsolidaginis* prove to belong to a distinct species. Both species belong to the genus *Apanteles* Först. as at present accepted. See my "Notes on N. A. Microgasters" (Trans. Ac. Sc. St. Louis, IV, *Author's separata*, p. 13.)

Microgaster gelechiæ.—Length 0.20 [$=5^{mm}$] ♂ ♀.—Black, clothed with a short, thin, glittering, whitish pubescence, most dense on the face, which latter is closely punctured; occiput and cheeks shining; mandibles rufopiceous; palpi whitish; eyes pubescent; antennæ as long as the body in ♂, shorter in ♀, 18-jointed; thorax shining, feebly punctured, mesothorax closely and more strongly punctured, with a deeply impressed longitudinal line on each side over base of wings; scutellum smooth and polished, the lateral groove broad, deep, arched and crenulated; metathorax opaque, densely rugose, with a sharp, central, longitudinal carina, and a smooth, flat, transverse carina at base; tegulæ testaceous, wings hyaline, iridescent, apex smoky, nervures blackish, areolet complete, subtriangular, radial nervure indistinct; legs pale honey-yellow, coxæ blackish, pale at tips, middle pair in ♀ concolorous with legs; abdomen with the two basal segments densely rugose and opaque, the remainder smooth and shining; venter more or less varied with pale testaceous.—[First Rept., p. 178.

This is a true *Microgaster*.

Perilitus indagator, N. Sp—Imago—♀, *Head* almost glabrous, transverse, deep honey-yellow, the trophi pale, except the tips of jaws, which are dusky; ocelli touching each other, black; eyes black, very large, occupying nearly the whole side of face, and with a few very short hairs; antennæ with about 24 joints, pale fuscous; reaching, when turned back, to about the middle of abdomen. *Thorax* honey-yellow beneath and very slightly pubescent; very finely punctured and slightly pubescent above; prothorax honey-yellow and prominently convex; mesothorax with lateral and posterior sutures black; metathorax black. *Abdomen* with the pedicel black and slightly punctured; depressed, narrow at base, widening behind, slightly pubescent above; the other joints glabrous, polished, deep honey-yellow, the second joint largest and as long as all the subsequent ones together; ovipositor extending about the length of the abdomen beyond its tip, rufous with the sheaths black. *Legs*

pale honey-yellow, the tarsi, especially at tips, slightly dusky, the hind femora and tibiæ a little dusky towards tips, and a narrow rufous ring at base of former. *Wings* hyaline, iridescent; veins brown; stigma honey-yellow, with an opaque brown cloud; two cubital cells, the outer small, sub-quadrate; the radial large; one discoidal, long and narrow. Length, exclusive of ovipositor, 0.18 inch [= 4.5mm].

Described from 1 ♀ bred from *Acrobasis juglandis*, LeB.—[Fourth Rept., p. 43.

SPATHIUS TRIFASCIATUS, N. Sp.—♀. Average length, 0.18 inch [= 4.5mm]. Color, light-brown. *Head* pubescent, palpi long and pale; eyes black; ocelli black, contiguous; antennæ smooth, pale, and reaching to second abdominal joint. *Thorax* with sutures dark-brown; legs more or less dusky, the tarsi (except at tip) an annulus at base of tibiæ, and the trochanters, pale; wings fuliginous, with a white fascia at base, at tip and across outer middle of front wing, including the inner half of stigma, the outer half of which is dark-brown; middle fascia most clearly defined. *Abdomen* slightly pubescent at sides and tip; first joint pale, petiolate, and with short and longitudinal aciculations above; second joint pale above, the others more or less brown; ovipositor pale, dusky at tip, and long as abdomen.

One bred specimen.

♂—Differs in being much darker colored, the head, thorax and femora being brown, and the metathorax and base of first abdominal joint black.

One bred specimen.—[Fifth Rept., p. 106.

BRACON CHARUS, N. sp.—♀ Length of body 0.35 inch [=8.7mm]; of ovipositor 0.40 inch [= 10mm]; expanse of wing 0.65 inch [=16mm]. Colors black and deep rufous. Head, thorax, legs and antennæ polished black, the legs and sides of head and thorax with a fine grayish pubescence; trophi also black. Abdomen uniformly deep rufous. Terebra of ovipositor pale yellow, the sheaths black and very faintly pubescent. Wings deep fuliginous with a faint zig-zag, clear line across the middle from the stigma.

Described from 7 ♀'s, all bred from *Chrysobothris femorata*.—[Seventh Rept., p. 75. Fig. 13.

BRACON SCOLYTIVORUS, Cress.—♀—Black, shining, metathorax and base of abdomen pubescent; face, anterior orbits, lower half of cheeks, clypeus, mandibles, except tips, palpi, tegulæ, legs, including coxæ, and abdomen, honey-yellow, the latter darker; posterior coxæ sometimes dusky; antennæ at base beneath, dull testaceous; wings fuliginous, apical half paler, iridescent; abdomen shining, first segment whitish laterally, the base and disc sometimes dusky; base of second segment with a large subtriangular flattened space inclosed by a deep groove, the posterior side of which is generally blackish; ovipositor longer than abdomen; sheaths black; length, .15—.17 inch [= $3\frac{3}{4}$—$4\frac{1}{4}$mm].

♂—More pubescent; posterior coxæ blackish, also the femora above, especially the posterior pair; posterior tibiæ dusky; abdomen black, polished: apex of first, basal half of second, and sides of apical segments more or less honey-yellow; sides of basal segment whitish; wings paler; abdomen narrower and rather more convex; length, .16 inch [=4mm].

Three ♂, three ♀ specimens.—[Mr. E. T. Cresson, in Fifth Rept., p. 106.

SIGALPHUS CURCULIONIS, Fitch—*Imago.*—*Head* black, sub-polished, and sparsely covered on the face with short whitish hairs; ocelli touching each other; labrum and jaws brown; palpi pale yellow; antennæ (Fig. 7, *c*) 27-jointed, filiform, reaching, when turned back, to middle joint of abdomen and beyond, the bulbus and small second joint rufous and glabrous, the rest black or dark brown, though 3–10 in many specimens are more or less tinged with rufous; 3–14 very gradually diminishing in size; 14–27 subequal. *Thorax* black, polished, the metathorax distinctly and broadly punctate, and the rest more or less distinctly punctate or rugose, with the sides sparsely pubescent. *Abdomen* pitchy-black, flattened, the dorsum convex, the venter concave, and the sides narrow-edged and slightly carinated; the three joints distinctly separated and of about equal length; the first joint having two dorsal longitudinal carinæ down the

middle; all densely marked with very fine longitudinally impressed lines, and sparsely pubescent; (Dr. Fitch in his description published in the *Country Gentleman*, under date of September, 1859, states that these lines leave "a smooth stripe along the middle of its second segment and a large smooth space on the base of the third;" which is true of a few specimens, but not of the majority, in which the impressed lines generally cover the whole abdomen.) Ovipositor longer than abdomen, but when stretched in a line with it, projecting backwards about the same length beyond; rufous, with the sheaths black. *Legs* pale rufous, with the upper part of hind tibiæ and tarsi, and sometimes the hind femora, dusky. *Wings* subhyaline and iridescent, the veins pale rufous, and the stigma black. Length ♀, 0.15–0.16 inch [=3.7–4^{mm}], expanse 0.30 [=7.5^{mm}]; ♂ differs only in his somewhat smaller size and in lacking the ovipositor. In many specimens the mesothorax and the eyes are more or less distinctly rufous.

Described from 50 ♀♀, 10 ♂♂, bred June 23d–July 29th, 1870, from larvæ of *Conotrachelus nenuphar*, and 2 ♀♀ obtained from Dr. Fitch.

Larva (Fig. 8, *a*)—White, with translucent yellowish mottlings.

Pupa (Fig. 8, *c* ♀)—0.17 inch [=4¼^{mm}] long; whitish, the members all distinct, the antennæ touching hind tarsi, the ovipositor curved round behind, reaching and touching with its tip the third abdominal joint, which afterwards forms the apical joint of imago; five ventral joints, which in the imago become much absorbed and hidden, being strongly developed.

Cocoon (Fig. *c*, *b*)—Composed of one layer of closely woven yellowish silk.

VARIETY RUFUS—Head, thorax, and most of the first abdominal joint entirely ufous, with the middle and hind tibiæ dusky, and the ovipositor three times as long as abdomen and projecting more than twice the length of the same beyond its tip.

Described from three ♀♀ bred promiscuously with the others. This variety is slightly larger and differs so remarkably from the normal form that, were it not for the absolute correspondence in all the sculpturing of the thorax and body, and in the venation of the wings, it might be considered distinct. The greater length of the ovipositor is very characteristic, and accompanies the other variation in all three of the specimens.—[Third Rept., p. 27. Fig. 7.

EURYTOMA BOLTERI, N. Sp.—♀ Length 0.18 inch [=4.5^{mm}]. Antennæ black, not much longer than the face, perceptibly thicker towards the end, and apparently 10-jointed, though the three terminal joints are almost always confluent. Dimensions and appearance of joints, represented in the annexed Figure 97, *a*. Head and thorax rough-punctured and finely bearded with short, stiff gray hairs. Abdomen about as long as thorax, scarcely so broad, viewed from above, but wider viewed laterally; highly polished, smooth and black, the three terminal segments with minute stiff gray hairs along the sutures; visibly divided into seven segments, the four anterior ones of about equal length, the two following shorter, and the terminal one produced into a point. Legs fulvous with the *coxæ*, [trochanters], thighs and more or less of the shanks blackish-brown. Wings perfectly transparent, glossy, colorless, and with the nerves very faint.

♂ Measures but 0.14 inch [=3.5^{mm}], and differs in the antennæ, being twice as long as the face, in their narrowing towards the tip and in being furnished with whorls of long hairs. The number of joints are not readily made out, and I have consequently presented at Figure 97, *b*, a magnified figure. His body is but half as wide and half as long as the thorax viewed from above, and not quite as broad as the thorax, viewed laterally; it it also lacks the produced point of the ♀. His wings are also cut off more squarely and more distinctly nerved.—[First Rept., p. 187. Pl. II, Fig. 9.

For further descriptive details see Walsh's posthumous paper on the *Eurytomides* (*Am. Ent.* II, p. 298–9), where the insect is looked upon as a variety of *Eurytoma diastrophi*.

[TRICHOGRAMMA MINUTA, N. Sp.] * * * It comes nearest the genus *Trichogramma*, Westw., and may be provisionally called *Trichogramma* (?) *minuta*. It differs

from that genus and from all other Chalcididan genera with which I am acquainted, in the antennæ being but 5-jointed (scape, plus 4 joints), the scape stout and as long, or longer, than joints 2, 3, and 4 together; joints 3 and 4 small and together as long as joint 2; 5 very stout, fusiform, and as long as 2, 3, and 4 together. The legs have the trochanters stout and long, the tibiæ not quite so long nor so stout as the femora, and with a long tooth; the tarsi are 3-jointed, with the joints of equal length and with the claws and pulvilli sub-obsolete. The abdomen is apparently 6-jointed, the basal joint wide, the 2nd narrower, 2–5 increasing in width till 5 is as wide as 1. The ovipositor of ♀ extends a little beyond the apex, and starts from the anterior edge of the 5th joint.—[Third Rept., p. 158. Fig. 72.

The species was provisionally referred to *Trichogramma*, and I subsequently proposed for it the generic name *Pentarthron* (Record of Am. Ent. 1871, p. 8). *Pentharthrum* has, however, been used by Wollaston in beetles, and until allied genera are better characterized than at present, the old generic name may be retained.

COLEOPTERA.

BRUCHUS FABÆ N. Sp. (Fig. 19,)—General color tawny-gray with more or less dull yellowish. *Body* black tinged with brown and with dull yellowish pubescence, the pygidium and sides of abdomen almost always brownish. *Head* dull yellowish-gray with the jaws dark brown and palpi black; antennæ not deeply serrate in ♀, more so in ♂; dark brown or black with usually 5, sometimes only 4, sometimes 4 and part of 5 basal joints, and with the terminal joint, more or less distinctly rufous, or testaceous, the color being so slight in some specimens as scarcely to contrast at all with the darker joints. *Thorax* narrowed before, immaculate, but with the pubescence almost always exhibiting a single pale medio-dorsal line, sometimes three dorsal lines, more rarely a transverse line in addition, and still more rarely (two specimens) forming a large dark, almost black patch each side, leaving a median stripe and the extreme borders pale and thus approaching closely to *erythrocerus* Dej.; base with the edges almost angulated; central lobe almost truncate and with a short longitudinal deeply impressed median line; no lateral notch; scutel concolorous and quadrate with the hind legs more or lest notched. *Elytra* with the interstitial lines having a slight appearance of alternating transversely with dull yellowish and dusky; so slight however that in most of the specimens it can hardly be traced: the dark shadings form a spot on each shoulder and three transverse bands tolerably distinct in some, almost obsolete in others, the intermediate row being the most persistent and conspicuous: between these dark transverse rows the interstices are alternately more or less pale, especially on the middle of the 3rd interstitial lines. *Legs* covered with grayish pubescence, and with the tibiæ and tarsi, especially of first and second pair, reddish-brown; the hind thighs usually somewhat darker, becoming black below and inside, and with a tolerably long black spine followed by two very minute ones. Length 0.09—0.14 inch [$=2\frac{1}{4}-3.5^{mm}$]. Described from 40 specimens all bred from different kinds of beans. Hundreds of others examined.

This insect has been for several years ticketed in some of the Eastern collections by the name of *B. fabæ*, or else, what is worse, the corruption of it, *fabi*. The former name has been disseminated by my friend F. G. Sanborn of Boston, Massachusetts, who says that he received the weevil thus named, together with beans attacked by it, in the year 1862 from Rhode Island. The name was credited to Fabricius, but I can find no notice in any of the works I possess of any European *Bruchus fabæ*, and several of my Eastern correspondents who have access to large libraries have been unable to find any description or allusion to a species by that name. Dr. LeConte has given it the MS name of *varicornis* but as his description will not appear perhaps for years to come and as no comprehensive description has yet been published, I have deemed it advis-

able to dispel in a measure the confusion that surrounds the nomenclature of the species. There is need of a description of so injurious an insect, and as *fabæ* is not preoccupied I adopt the name because it is entirely appropriate and because it is more easily rendered into terse popular language than *varicornis.*

It resembles most closely of any other species which I have seen, the *B. erythrocerus*, Dej., which, however, is smaller, and differs in having a narrower thorax which has light sides and a dark, broad dorsal stripe divided down the middle by a pale narrow line: *erythrocerus* is further distinguished by the antennæ being entirely testaceous and the hind thighs more swollen.

From *obsoletus* Say, *fabæ* differs materially: *obsoletus* is a smaller species, dark gray, with the antennæ all dark, the pygidium not rufous, the thorax with a perceptibly darker dorsal shade so that the sides appear more cinereous, a white scutel, and each interstitial line of the elytra with a slight appearance of alternating whitish and dusky along its whole length; for though there is nothing in Say's language to indicate whether it is the interstitial lines that alternate transversely, whitish and dusky, or each line that so alternates longitudinally, I find from an examination of a specimen in the Walsh collection, that the latter is the case, and so much so that the insect almost appears speckled. The two species differ both in size and color, though, as Say's description is short and imperfect it is not surprising that *fabæ* should have been referred to it.

From the European bean-feeding *Br. flavimanus* (which is apparently either a clerical error for, or a synonym of *Br. rufimanus*, Schœnh.) as described by Curtis, it differs notably; as it does likewise from their *Br. serratus*, Ill., which also attacks beans.

Dr. LeConte, according to Mr. Rathvon, was inclined to consider this insect the *obsoletus* of Say, from the fact that in specimens which the latter gentleman sent him, the antennæ were not varied as in his MS. *varicornis*, but uniformly black. A few specimens which Mr. Rathvon sent me nearly two years ago, taken from the same lot as were those which he forwarded to Dr. LeConte, were singularly enough, all decapitated but two; and these two showed the varied antennæ. These specimens had all been kept in alcohol, and I am greatly inclined to believe that the uniformly dark appearance of the antennæ that was noticed by LeConte was the effect of the alcohol on those which naturally had the rufous joints but faintly indicated. At all events, though Mr. Rathvon tells me that he found a small proportion of beetles with dark antennæ, after examining, at my suggestion, over two hundred specimens that had thus been kept in alcohol; yet from over one hundred specimens which he had the kindness to send me, I only find (after thoroughly drying them) three with the terminal joint really as dark as the subterminal, and not a single one in which the rufous basal joints cannot be more or less distinctly traced.—[Third Rept., p. 55–56. Fig. 19.

Since the above was written, Dr. Horn has given us a revision of the *Bruchidæ* of the United States (Trans. Am. Ent. Soc., Vol. IV, 1873), in which he makes *fabæ* a synonym of *obsoletus* Say, expresses regret that another synonym must be added and states that the *obsoletus* which I referred to is the *transversus* Say (=*hibisci* Oliv.). This criticism is not deserved, and while the decision of one who has done such excellent work in Coleoptera as Dr. Horn has will be generally accepted as final, yet no one can compare his redescription of *obsoletus* with Say's description and not feel that the two apply to different insects. *Fabæ* is usually one-third larger, tawny-gray above with vari-colored antennæ, concolorous scutel, emarginate behind, and rufous legs and abdomen; *obsoletus*, on the contrary, according to Say, is blackish-cinereous, the thorax cinereous each side, with a whitish scutel and with the abdomen and legs not differing in color from the rest of the body. *Fabæ* breeds in beans; *obsoletus* in the seeds

of *Astragalus*. Indeed one would be far more justified in considering *B. alboscutellatus* Horn a synonym of *obsoletus* Say than in considering *fabæ* a synonym of it, and when the Bruchus from Astragalus in the Eastern States is bred, I fully expect Dr. Horn to change his mind. Nor is the assumption justifiable that the *obsoletus* referred to by me, and destroyed in the Walsh collection, is *hibisci* Oliv. It was far more like *alboscutellatus* as far as I remember, and there is not a character about this species which does not accord with Say's description of *obsoletus* except that the scutel is described as *rounded*, while that of *obsoletus* is described by Say as quadrate. I am of opinion that too much stress has been laid on this difference by Dr. Horn, as, when the pubescence is separated behind, the scutel appears quadrate, whereas in *fabæ* it appears bifid. The scutel of *alboscutellatus* when denuded is quadrate, but it is doubtless the clothed appearance which Say described. Say, as appears from his text, had abundant material, and it is assuming too much to suppose that he could overlook the striking differences in size and coloration of *fabæ*, as above indicated.

The specific name *fabæ* was used by Brullé for *Bruchus pisorum* Linn.

MADARUS VITIS, N. Sp.—Length, exclusive of rostrum 0.10 [inch=2.5^{mm}]. Color uniformly rufous, without maculations, the eyes alone being darker. Highly polished; rostrum arcuated, stout and about as long as thorax; thorax and body with extremely minute and distant punctures, anterior margin of thorax abruptly narrowed, especially laterally, into a collar; elytra slightly undulate, with 4 distinct elevations, one on the extreme outer margin close to the thorax, and one on the middle of each, near the extremity.—[First Rept., p. 132. Fig. 74.

For further details as to the synonymy of this insect, see *American Entomologist* I, p. 105. Dr. LeConte's description of *Baridius sesostris* was published about three months earlier than my own and he subsequently (Proc. Amer. Phil. Soc., Vol. XV, 1876, p. 299) erected the genus *Ampeloglypter* for this and two other species, so that *Madarus vitis*=*Ampeloglypter sesostris* Lec.

ANALCIS FRAGARIÆ, N. Sp.—*Imago*, (Fig. 14, *b*, *c*)—Color deep chestnut-brown, subpolished, the elytra somewhat lighter. Head and rostrum dark, finely and densely punctate and with short fulvous hairs, longest at tip of rostrum; antennæ rather lighter towards base, 10-jointed, the scape much thickened at apex, join 2 longest and robust, 3 moderately long, 4–7 short, 8–10 connate and forming a stout club. Thorax dark, cylindrical, slightly swollen across the middle and uniformly covered with large thimble-like punctures, and with a few short coarse fulvous hairs, unusually arranged in three more or less distinct longitudinal lines; pectoral groove ending between front legs. Abdomen with small remote punctures and hairs which are denser towards apex. Legs of equal stoutness, and with shallow dilated punctures and uniform very short hairs. Elytra more yellowish-brown, dilated at the lower sides anteriorly, and with about 9 deeply-punctured striæ, the striæ themselves sometimes obsolete; more or less covered with coarse and short pale yellow hairs which form by their greater density, three more or less conspicuous transverse bands, the first of which is at base; between the second and third band, in the middle of the elytron, is a smooth dark-brown or black spot, with a less distinct spot of the same color below the third, and a still less distinct one above the second band. Length 0.16 inch [=4^{mm}].

Described from four specimens bred from strawberry-boring larvæ. The black spots

on the elytra are quite distinct and conspicuous on two specimens, less so on one, and entirely obsolete on the other.

Larva, (Fig. 14 *a*)—White with back arched Lamellicorn-fashion. Head gamboges yellow, glabrous, with some faint transverse striations above mouth; mandibles rufou-tipped with black; labrum emarginate, and with palpi, pale. A faint narrow dorsal vasculer line. Legs replaced by fleshy tubercles. Length 0.20 inch [=5mm] when stretched out.—[Third Rept., p. 44. Fig. 14.

Say's generic name *Tyloderma* having priority over Schönherr's *Analcis*, the name of this insect becomes *Tyloderma fragariæ*.

LEPIDOPTERA.

ÆGERIA RUBI, N. Sp.—*Imago.*—Expanse, ♂, 1.00 [inch=25mm]; ♀, 1.25 inch [=31mm]. Front wings transparent, with a broad costal border extending half the width of wing at base, a narrow discal spot, and more or less of the tip dull-ferruginous; the inner border, the inner longitudinal vein, the intermediate space toward posterior angle, and sometimes its whole length, of the same color; veins brownish within and black without the discal spot. Hind wings perfectly transparent, or rarely with a few sparse ferruginous scales; the transverse discal vein pale, the others pale at base, but black toward extremities; costa narrowly golden-yellow, becoming darker toward apex. Fringes dark-brown, those of hind wings appearing darkest by virtue of a dark wing border. Under surface somewhat paler. Abdomen stout, with a very slight anal tuft in ♀; a stouter one in ♂. Antennæ blue-black, not enlarging toward tip, quite pectinate in ♂. Palpi, a narrow ring around neck, the sides of the collar, a broad band curving across tegulæ and around the base of wings, a faint line across middle of thorax, two faint longitudinal lines between it and collar, legs, except outer base (sometimes whole length) of femora and tibiæ, hind third of abdominal joints, and a dorsal and lateral series of abdominal tufts or patches (the dorsal ones, especially on 3d and 7th joints, most persistent and conspicuous)—all golden-yellow: the rest of body black. The orbits are of a somewhat paler-yellow, and the face either gray or bluish.

♂ differs from ♀ in the darker color of primaries, the narrower fringe of secondaries, the narrower ferruginous spot at apex of primaries, the more tufted abdomen, the broader and darker anal tuft, and the pectinate antennæ.

Described from 6 ♂'s, 6 ♀'s, bred from *Rubus*. Approaches nearest to *Trochilium marginatum* Harr., and *T. tibiale* Harr.,* from which it differs in the thoracic marks and the abdominal tufts.

Larva—Length 0.90–1.10 inch [=22.5–27.5 mm]; diameter 0.18 [=4.5mm]. Color pale-yellow. Head dark-brown, with a few whitish hairs; mandibles black, the other trophi paler. Cervical shield horny, pale-brown. Each joint with 8 pale, shiny piliferous spots, transversely arranged on 2, 3 and 12; the dorsal 4 quadrangularly arranged and the lateral 2 interrupted by stigmata on all the others. Thoracic legs slightly tinged with brown; prolegs, with the hooklets dark. Several specimens examined.—[Sixth Rept., p. 113. Fig. 30.

ACRONYCTA POPULI, N. Sp.—*Larva*—Length 1.50 [inch, =37mm]. Color yellowish-green, covered with long soft bright yellow hairs which spring immediately from the body, part on the back, and curl round on each side. On top of joints 4, 6, 7, 8 and 11, a long straight double tuft of black hairs, those on 7 and 8 the smallest. Head polished black with a few white bristles. Joint 1 with a black spot above, divided longitudinally by a pale yellow line, giving it the appearance of a pair of triangles. Joint 2 with two less distinct black spots. Thoracic legs black; prolegs black with brownish extremities. Venter greenish-brown. Described from many specimens. When young of a much lighter color, or almost white, with the black tufts short but

* Silliman's Am. Journ. of Sc., XXXVI, p. 309 (1839).

more conspicuous, with a distinct black dorsal line, two lateral purplish-brown bands, and with hairs white, sparse and straight.

Individuals vary much: some have a black dorsal line, some have but three distinct black tufts; some have a sixth tuft of black hairs on joint 9, and others have a few black hairs on all but the thoracic joints. Just before spinning up, many of the hairs are frequently lost, and the body acquires a dull livid hue.

Moth.—♀, front wings, white, finely powdered with dark atoms which give them a very pale gray appearance; marked with black spots as follows: a complete series of small spots on posterior border extending on the fringes, one between each nerve; near the anal angle between nerves 1 and 2 a large and conspicuous spot bearing a partial resemblance to a Greek *psi*, placed sidewise, and from this spot a somewhat zigzag line running parallel with posterior border, but somewhat more arcuated towards costa, least distinct between nerves 3 and 4, and forming a large distinct dart-like spot between nerves 5 and 6; space between this line and posterior border, slightly darker than the rest of the wing-surface on account of the dark atoms being more thickly sprinkled over it; four costal marks, one subobsolete in a transverse line with the reniform spot, one conspicuous about the middle, and in a line with reniform spot and anal angle, one about the same size as the last and looking like a blurred X about one-third the length of wing from base, and one subobsolete, near the base; orbicular spot flattened and well defined by a black annulation; reniform spot indicated by a blurred black mark running on the cross-vein and sometimes somewhat crescent-formed; a V-shaped spot pointing towards base half-way between costa and interior margin, in a transverse line with the large costal spot which looks like a blurred X; a blurred mark in middle at base, and lastly a narrow spot on the inferior margin, half-way between base and anal angle. Hind wings same color as front wings; somewhat more glossy, with the lunule, a band on posterior border one-fourth the width of wing, and sometimes a narrow coincident inner line, somewhat darker than the rest; the posterior border also with a series of spots one between each nerve. Under surface of front wings pearly-white with an arcuated brown band, most distinct towards costa, across the posterior one-third, all inside of this band of a faint yellowish-brown; lunule and fringe spots distinct, and with a faint trace of the *psi*-spot; hind wings uniform pearly-white with a distinct and well defined dark wavy line running parallel with posterior margin across the posterior one-third of wing, and with the lunule and fringe spots distinct. Antennæ simple and bristle-formed, gray above, brown beneath. Head thorax and body, both above and below, silvery-gray. Legs with the tarsi alternately dusky and gray. ♂ differs from ♀ by his somewhat stouter antennæ; much narrower body, and narrower wings and fringes, the front wings having the apex more acuminate, and the hind wings scarcely showing the darker hind border.

Described from 2 ♀, 2 ♂ all bred. In the ornamentation of the front wings this species bears some resemblance to the European species *tridens* and *psi*, but otherwise differs remarkably, and especially in its larval characters. It bears a still closer resemblance both in the larva and imago state to the pale variety of a common species known in England as the "Miller" (*A. leporina*), but judging from the figures and description in "Newman's Natural History of British Moths," it may be easily distinguished from *leporina* by the well defined orbicular spot, by the greater proximity of the two large costal spots, by lacking a round spot behind the disk, and by the more prolonged apex. It differs also in the larva state from *leporina* which feeds on the Birch. It likewise closely resembles *interrupta*, though the larvæ are remarkably different; and it also resembles *lepusculina*, the larva of which is unknown; but the specific differences will be readily perceived upon comparing Guenée's descriptions. How near it approaches to *Acronycta occidentalis*, Grote, it is impossible to tell, as the author's description is exceedingly brief, considering the number of closely allied forms; but as that species has a bright testaceous tinge on the reniform spot, it evidently differs from mine. Harris's *Apatela* [*Acronycta*] *Americana*, though very differ-

ent in the imago, yet closely resembles *populi* in the larva state. I have on two occasions found the larva of *Americana* feeding on the Soft Maple, and it may be distinguished from *populi*, by its greater size; by the paler color of the body; by the hairs being paler, more numerous, shorter and pointing in all directions, especially anteriorly and posteriorly of each segment; by having on each of joints 4 and 6 two distinct long black pencils, one originating each side of dorsum, and on joints 11 one thicker one originating from the top of dorsum; by a substigmatal row of small black spots (three to each segment, the middle one lower than the others) and by a trapezoidal velvety black patch starting from anterior portion of joint 11 and widening to anus.—[Second Rept., pp. 120, 121. Figs. 87, 88.

Grote refers it, in his *List*, to *lepusculina* Gn.; having, I believe, seen the type. Guenée must have had a uniformly colored and pale specimen as my typical specimens have a distinct orbicular mark, deeper subterminal markings and the terminal space contrasting by its darker gray with the rest of primaries—all unmentioned in Guenée's description.

XYLINA CINEREA, N. Sp.—*Larva*—Length when full grown 1.20—1.30 inches [=30—32mm], color shiny silvery-green on the back, darker below. A medio-dorsal cream-colored stripe: a subdorsal one represented by 3 or 4 irregularly shaped spots on each joint. A broad deep cream-colored stigmatal line, with a few green dents in it, extending to anal prolegs. Four slightly elevated cream-colored spots, encircled by a ring of rather darker green than the body, in the dorsal space, and in the subdorsal space there are four or more similar but smaller spots. Venter glaucous-gray. Head as large as joint 1, free, glassy-green with white mottlings at sides and top, and pearly-white lips. Thoracic legs whitish. Prolegs concolorous with venter. When young the body is darker and the markings paler. Described from two living specimens.

Imago (Fig. 57, *b*)—*Front wings*, with the ground-color pale cinereous shaded and marked either with light brown, having a faint purplish tint, or with darker brown, having a similar reflection, or with a colder grayish-brown with the faintest moss-green reflection: in the first two cases the dark color either blends and suffuses with the ground-color so as to give the wing a nearly uniform and smooth appearance, or else contrasts sufficiently to bring out all the marks distinct: in the latter case (two specimens) the markings are very distinct and the ground color is whiter and more irrorate. In the well-marked specimens the usual lines are readily distinguished, the basal half line, transverse anterior and transverse posterior being quite wavy, pale, and bordered each side with a dark shade, the median shade dark and well defined and the subterminal line, though sometimes pale near costa, forming a series of dark angular spots: in the more uniform specimens these lines are barely distinguishable and perhaps the most constant is the sub-terminal which most often takes the form of a series of dark angular spots: the ordinary spots have a pale inner and a more or less distinct dark outer annulation: the orbicular is larger than the reniform and is sufficiently double to take on the form of an 8, the upper part of which is always largest and with the interior space paler than the general surface, while that of the lower part is either concolorous or darker; the form is, however, quite irregular and differs sometimes in the two wings of the same species: the reniform spot is generally well defined, and is either darker, or has a tinge of reddish-brown, interiorly: at the base of the wing is a more or less distinct pale space occupying the upper half, and bordered below by a brown line which is straight about half its length and then extends upwards and outwards towards transverse anterior. A tolerably distinct terminal line, with the fringes dark. In taking a general view of the varying specimens this pale basal space, the pale upper part of the orbicular and the dark subterminal line, seem to be the most constant characters of the species. *Hind wings* gray-brown in-

clining to cinnamon-brown, with the posterior border but slightly darker and the fringe paler. Under surface quite uniform, that of front wings being nacreous gray with a faint discal spot and with a narrow costal and broad terminal border of pale fulvous, dusted with purple-gray: the hind wings of this last color with the lunule and line distinct. *Head* nearly entire, though the quadrifid arrangement of the hairs is traceable; palpi hairy throughout. *Thorax* quite square, of same color as primaries and with the collar bordered behind with brown and sometimes the edges of the tegulæ similarly bordered. *Abdomen* of same color as hind wings with lateral tufts, and cut off squarely at apex. Expanse 1.32—1.82 inches [= 34 — 45^{mm}].

Described from 3 specimens fed on grape-vine, 2 on peaches and 1 on *Cercis canadensis*. Other captured specimens examined.

This species is the analogue of, and very closely resembles the European *Xylina conformis*, which is known under various synonyms. A specimen sent to Mr. P. C. Zeller of Stettin, Prussia, was, however, pronounced distinct. The well-marked irrorate form still more closely resembles Guenée's *cinerosa* found in Switzerland, and which he himself thinks may prove to be a variety of *conformis*. The more I study the species of the NOCTUIDÆ as they occur in nature, the more I am struck with their great variability, and there can be no doubt that many of the so-called species will turn out to be but varieties when we better understand them. In this large family none but the more strikingly marked species should ever be described without an accompanying description of their preparatory states and of their principal variations. I am unacquainted with any of Walker's species except *subcostalis*, which is very different, and if this should prove to be a synonym of any of them the fault must be laid to the difficulty under which the naturalist in the Western States labors for want of proper libraries to refer to. It differs essentially from Grote's *Bethunei* and *capax* as described and illustrated in Volume I of the Transactions of the American Entomological Society. I am informed by Mr. [J.] A. Lintner of Albany, N. Y., that Dr. A. Speyer of Rhoden, Fürstenthum Waldeck, Prussia, who gives much attention to the Noctuidæ, has it marked *Celœna oblonga* in his MS., but the insect evidently does not belong to that genus, and as the German pronunciation of *Xylina* much resembles the English pronunciation of *Celœna*, the reference to the latter is doubtless due to a verbal misunderstanding.—[Third Rept., pp. 135, 136. Fig. 57.

Now referred, in Grote's *List of Noctuidæ of N. A.*, to Hübner's genus *Lithophane*.

AMPHIPYRA CONSPERSA, N. Sp.—*Larva.*—Found full grown July 2, 1867, on Hazel. No pyramidal hump, and of a uniform emerald-green, the dorsal palpitations visible and the stigmata pale, with a black annulation, but with no other markings either on the head, body, or legs.

Imago—Like *pyramidoides* in every particular except that the brown of front wings is almost uniformly spattered over, more or less suffusely, with pale-grayish spots, so that no regular marks appear. The costal marks are, however, tolerably distinct as in *pyramidoides*, and by careful examination and comparison traces of the more conspicuous marks of that species may be discerned.

Described from one ♀ bred July 31.—[Third Rept., p. 75.

As remarked at the time, the specimen from which the description was made was a bred one and perfect. Grote, in his *List of Noctuidæ*, considers it simply an aberration of *pyramidoides*, but this can hardly be the case, as the larva also shows differences.

AGROTIS SCANDENS, N. Sp.—*Larva.*—Average length when full grown 1.40 [inch, = 35^{mm}]. Ground-color very light yellowish gray, variegated with glaucous in the shape of different sized patches, which are distinctly see nunder the lens to be separated by fine lines of the light ground-color. A well-defined dorsal and less distinct

subdorsal and stigmatal line, caused by these patches becoming larger and darker; another and still less distinct line of the same kind under stigmata. The dorsal line frequently with a very fine white line along its middle, especially at sutures of segments. Piliferous spots in the normal position; those above black, those at the sides lighter. Stigmata black. Head and cervical shield tawny, the latter with a small black spot each side, the former with two in front, and two eye-spots each side. Caudal plate tawny, speckled with black. Venter and legs glaucous. Bristles fine and small. Filled with food it wears a much greener appearance than otherwise, while when young it is of a more uniform dirty whitish-yellow, the lines less distinct but the piliferous spots proportionately larger. Head quite variable in depth of shade.

Perfect Insect.—Average length 0.70 [inch, $= 17.5^{mm}$]; alar expanse 1.50 [inch, $= 37^{mm}$]. General color of fore wings very light pearly bluish-gray, with a perceptible deepening posteriorly. Quite variable, sometimes of a more decided blue, at others inclining to buff as in *Leucania unipuncta*, Haw. Markings, when distinct, as in Plate 1, Figures 5 and 6. With the exception of the reniform spot and subterminal line, however, they are usually distinct only on costa, being either indistinct or entirely obsolete on the rest of the wing. The subterminal line is light, with a more or less dark diffuse shade each side, which, in some instances, forms into sagittate spots. A black stain at the lower part of reniform spot forms a most distinctive character. Hind wings very pale and lacking the bluish cast of fore wings; lunule distinct, and a dark shade, enclosing a lighter mark, as in *Heliothis*, along posterior margin. Eyes dark; head and thorax same as fore wings; abdomen same as hind wings. The whole under surface the same as hind wings above, the lunules and arcuated bands faintly traced, the fore wings having a darker shade in the middle.

Described from 30 bred specimens.—[First Rept., pp. 78–79. Pl. 1, Figs. 5, 6.

AGROTIS COCHRANII, Riley—*Imago.*—Fore wings of a light warm cinereous, shaded with vandyke brown and umber, the terminal space, except at apex, being darker and smoky. Basal, middle and limbal areas of almost equal width, the middle exceeding somewhat the others. A geminate dark basal half-line, usually quite distinct. Transverse anterior geminate, dark, somewhat irregularly undulate, and slightly obliquing outwards from costa to interior margin. Transverse posterior geminate, the inner line being dark, distinct and regularly undulate between the nerves, while the outer line is plain and much paler; it is arcuated superiorly and inversely obliques for two-thirds its width. Orbicular and reniform spots of normal shape, having a fine, dark annulation, which is however obsolete in both, anteriorly; the orbicular is concolorous with the wing, whilst the reniform has a dark inner shade with a central light one, and forms with the transverse posterior a somewhat oval spot which is also dark. Median shade dark and distinct interiorly, shading off and becoming indistinct in center of wing, and quite dark between the two spots, giving them a fair relief. Subterminal line single, light, acutely and irregularly dentate, with an inner dark shade, but warmer than that of terminal space. Terminal line very fine, almost black, slightly undulate. Fringes of same color as wing, with a light central line, having an outer dark coincident shade. A dark costal spot in basal area; at termini of the usual lines, and two light ones in subterminal space. In some specimens one or two fine dark sagittate marks are discernable, and also a fine black claviform mark. Hind wings: whitish, with a darker shade along posterior margin. Under surface of fore wings somewhat lighter than the upper surface and pearlaceous interiorly, with a smoky arcuated band—more definite near the costa than elsewhere—and a tolerably distinct lunule. Under surface of hind wings concolorous; slightly irrorate with brown anteriorly and posteriorly, and with an indistinct lunule and band. Antennæ, prothorax, thorax, tegulæ and body of same color as primaries, the prothorax having a darker central line, and in common with the tegulæ a carneous margin. Under surface lighter; legs with the tarsi spotted.

This moth, in its general appearance, bears a great resemblance to *Hadena chenopodii*, but the two are found to differ essentially when compared. From specimens of *H.*

chenopodii, kindly furnished me by Mr. Walsh, and named by Grote, I am enabled to give the essential differences, which are: 1st. In *A. Cochranii*, as already stated, the middle area exceeds somewhat in width either of the other two, while in *H. chenopodii* it is but half as wide as either. 2d. In the *Agrotis* the space between the spots and between the reniform and transverse posterior is dark, relieving the spots and giving them a light appearance, whilst in the *Hadena* this space is of the same color as the wing, and the reniform spot is dark. The claviform spot in the *Hadena* is also quite prominent, and one of its distinctive features, while in the *Agrotis* it is just about obsolete.

There are specimens that seem to be intermediate between these two, but all those bred by me, both male and female, were quite constant in their markings, and their intermediates will doubtless prove to be distinct species or mere varieties.

Larva—Length 1.07 inches [=26.8^{mm}]. Slightly shagreened. General color, dingy ash-gray, with lighter or darker shadings. Dorsum light, inclining to flesh color, with a darker dingy line along its middle. The sides, particularly along the sub-dorsal line are of a darker shade. On each segment there are eight small, black, shiny, slightly elevated points, having the appearance of black sealing-wax, from each of which originates a small black bristle. The stigmata are of the same black color, and one of the black spots is placed quite close to them anteriorly. Head shiny and of the same dingy color as the body, with two darker marks, thick and almost joining at the upper surface, becoming thinner below and diverging toward the palpi. The upper surface of first segment is also shiny like the head. Ventral region of the same dingy color, but lighter, having a greenish tinge anteriorly and inclining to yellow under the anal segment. Legs of same color. It has a few short bristles on the anterior and posterior segments.

Chrysalis.—Length 0.70 of an inch [= 17.5^{mm}]. Light yellowish brown with a dusky line along top of abdomen. Joints, especially of the three segments immediately behind the wing-sheaths, dark brown. The brown part of these three segments, minutely punctured on the back. Eyes dark brown, and just above them, a smaller brownish spot. Two quite minute bristles at extremity.

Described from numerous bred specimens. — [First Rept., pp. 75–76. Fig. 26.

There is little question but that this is the moth briefly characterized by Harris (Ins. Inj. to Veg., p. 444) as *Agrotis messoria*, an examination of the types confirming this view. *A. repentis* G. & R. and *A. lycarum* are also conceded by Grote to be synonyms.

PLUSIA BRASSICÆ, N. Sp. —*Larva*—Pale yellowish translucent green, the dorsum made lighter and less translucent by longitudinal opaque lines of a whitish-green; these consist each side, of a rather dark vesicular dorsal line, and of two very fine light lines, with an intermediate broad one. Tapers gradually from segments 1–10, descending abruptly from 11 to extremity. Piliferous spots white, giving rise to hairs, sometimes black, sometimes light colored; and laterally a few scattering white specks in addition to these spots. A rather indistinct narrow, pale stigmatal line, with a darker shade above it. Head and legs translucent yellowish-green, the head having five minute black eyelets each side, which are not readily noticed with the naked eye. Some specimens are of a beautiful emerald-green, and lack entirely the pale longitudinal lines. Described from numerous specimens.

Chrysalis— Of the normal *Plusia*-form, and varying from yellowish-green to brown.

Moth—*Front wings* dark gray inclining to brown, the basal half line, transverse anterior, transverse posterior, and subterminal lines pale yellow inclining to fulvous, irregularly undulate, and relieved more or less by deep brown margins; the undulations of the subterminal line more acuminate than in the others, and forming some dark sagittate points; the basal half-line, the transverse anterior near costa, and the transverse posterior its whole length, being sometimes obscurely double: four distinct equidistant costal spots on the terminal half of wing, the third from apex formed by

the termination of the transverse posterior; posterior border undulate with a dark brown line which is sometimes marked with pale crescents; a series of similar crescents (often mere dots) just inside the terminal space; the small sub-cellulary silver spot oval, sometimes uniformly silvery-white but more often with a fulvous centre, sometimes free from, but more often attached to the larger one which has the shape of a constricted U, very generally with a fulvous mark inside, which extends basally to the transverse anterior at costa. Fringes dentate, of the color of the wing, and with a single undulating line parallel to that on the terminal border. *Hind wings* fuliginous, inclining to yellowish towards base, and with but a slight pearly lustre; fringes very pale with a darker inner line. Under surfaces pale fuliginous with a pearly lustre, the front wings with a distinct fulvous mark under the sub-cellulary spots, speckled more or less with the same color around the borders of the wing, the fringes being dentate with light and dark; the hind wings speckled with fulvous on their basal half, and with the fringes as above. *Thorax* variegated with the same color as front wings, the tufts being fulvous inclining to pink. *Abdomen* ♀ gray, with a few pale hairs near the base, and scarcely extending beyond the margin of the hind wings; ♂ longer, covered with pale silky hairs, a distinct dorsal brown tuft on each of the three basal segments, and two large lateral either fawn-colored or golden-yellow brushes on the fifth segment, meeting on the back and partly covering two smaller brushes on the sixth, which are tipped with black; terminal segment flattened and with two lateral more dusky and smaller tufts: underside of thorax and abdomen gray, mixed with flesh-color. Alar expanse 1.55 inches. Described from numerous bred specimens. In a suite of specimens bred from the same brood of larvæ a considerable difference in the general depth of color is found, some being fully as dark again as others.

Closely resembles *Plusia ni*, Engr., which occurs in Italy, Sicily, France, and the northern parts of America. Mr. P. Zeller of Stettin, Prussia, to whom I sent specimens, considers it distinct however from the European *ni*, and I have consequently given it a name in accordance with its habits. — [Second Rept., pp. 111–112. Fig. 81.

Notwithstanding its close resemblance to *ni*, the best authorities agree with Zeller in considering it distinct, as it certainly is. Strangely enough this same *brassicæ*, or what is extremely close to it, occurs also in South Europe and is figured in Stainton's *Entomologist's Annual* for 1870 as *P. ni*, one specimen having been found on the south coast of England, which specimen Zeller, as he wrote me, believes to have come from America. Staudinger would probably characterize *brassicæ* as a "species Darwiniana," and there are doubtless individuals of both the species which approach each other so closely as to be undistinguishable. There is such variation in the silver spot in either that it cannot be depended on alone, but Speyer (Europäisch-Americanische Verwandtschaften; *Stettiner Ent. Zeit.*, June, 1875, p. 165) has presented other differences that are constant in detail, the most noticeable of which are the darker and more irrorate coloring and the interrupted and wavy terminal line of *brassicæ*, against the paler, smoother, more metallic coloring and the perfectly straight and unbroken terminal line of *ni*.

The larva is the most common cabbage pest in the Southern States, and is infested with an undetermined parasite. Mr. E. A. Popenoe has found it feeding on the leaves of *Crepis*, and what appears to be the same has been found by my assistants on Clover, Dandelion, *Senecio scandens*, and *Chenopodium*.

APLODES RUBIVORA, N. Sp. — *Larva* — Average length 0.80 inch [= 20mm]. Color light yellowish-gray, darker just behind each joint, and very minutely shagreened all over. On each segment a prominent pointed straight projection each side of dorsum, and several minor warts and prickles below. Two very slightly raised, longitudinal lighter lines along dorsum, between the prominent prickles. Ten legs.

Perfect insect — Alar expanse 0.50 inch [= 12.5mm]; length of body 0.25 inch [= 6mm]. Color verdigris-green, the scales being sparse so that the wings appear sub-hyaline. Fore-wings with two transverse lighter lines dividing the wing into three parts, proportionate in width as 3, 4, 2 counting from base, and parallel with posterior margin; also a faint line between these two, running to about ½ of wing from costa. Hind wings with two similar transverse lines, dividing the wing in like proportion, the outer line not parallel with margin, but wavy and produced posteriorly near its middle. Costa pale; fringes obsolete. Head, thorax and abdomen green above, but, together with antennæ and palpi, white beneath.

Described from one ♀ specimen. — [First Rept., pp. 139–140. Pl. II, Fig. 25.

Dr. Packard, in his Monograph of the Geometred Moths, etc. (U. S. Geol. Surv. of Terr., Vol. X, 1876, p. 382), refers it to the genus *Synchlora* Gor., and adds the conventional ending to the specific name, so that the species becomes *Synchlora rubivoraria*. *Synchlora albolineata* Pack. and *Eunemoria gracilaria* Pack. are given as synonyms.

PHYCITA [ACROBASIS] NEBULO, Walsh—*Imago*.—I reproduce here the description of the moth in Mr. Walsh's original words: "Expansion of wings 7-10. Length of body 3-10. General color light cinereous, varied with dusky. A row of about seven subsemilunar or linear dark spots on outer margin of fore wing. Then one-fourth of the distance to the body a waving light cinereous band parallel to the exterior margin, marked on each side with dusky black. Nearly at the centre a much abbreviated black band. Beyond the centre on the costal margin a subtriangular dusky black spot, the apex of which connects with the apex of a much larger subobsolete triangular brick-red spot which extends to the interior margin, and is bounded on the outside by a wavy light cinereous band, which is again bounded by a wavy dusky black band proceeding from the apex of the costal triangle. Base of wing dusky black, inclosing a small round light cinereous spot. Hind wings and all beneath light cinereous shaded with dusky, the fore wings darker. Tarsi dusky with a narrow light cinereous fascia at the apex of each joint. Hind tibia fasciate with dusky at the apex, sometimes obscurely bifasciate. Intermediate tibia fasciate with dusky at the centre, the fascia generally extending to the base, but becoming lighter. Anterior tibia dusky, with a narrow apical light cinereous fascia. Palpi, both labial and maxillary, dusky."

When compared with other closely allied and resembling species, this little moth may be characterized in the following manner: The ground color of the front wing is decidedly bright and pale; the discal spots are almost always confluent, thus forming an abbreviated transverse bar; the dark markings are well defined and the triangular dark costal spots starting from the inner third of the wing is distinctly relieved, while the "brick-red" (nearer a cinnamon-brown) triangular spot which opposes it is large, so that the space it occupies on the inner margin is nearly as wide (generally within one-third) as that between it and the transverse posterior line. The lower half of the basal space is often of a distinct cinnamon-brown, and an oblique dusky band, which Mr. Walsh has not mentioned, is often quite distinct, running from near the apex to the brown triangle, where it connects with the inner margin. The species recalls, in facies, the European *Myelois suavella*. In a suite of specimens bred from Apple, Quince, Plum and Cherry, there is sufficient variation to prevent a too rigidly drawn description, but the above characters obtain in all of them, and such variation as occurs runs in the direction of the variety presently to be described.

Larva—[Length 0.5 inch] Brown or greenish in color. Cylindrical. Tapering grad-

nally from first to last joint. Head and cervical shield darker than the rest of body, slightly shagreened, sparsely covered with long hairs, the shield quite large, convex, and occupying the whole surface between stigmata—there being in front of the latter a sub-cervical dark horny plate. Joints 2 and 3 wrinkled as at Fig. 18, *c* the former with two rather conspicuous dark dorsal piliferous spots. The other joints with a few fine hairs, the stigmata plainly visible, and the anal covering but slightly horny. Legs and prolegs of moderate size and of same color as body.

Described from numerous specimens.

Chrysalis—Mahogony-brown, with no striking character. Abdomen, especially above, with very minute punctures.

VARIETY NEBULELLA (Fig. 20, *e*).—I have bred a single specimen from wild Crab (*Cratægus*) which differs in some essential features from the normal form, but which nevertheless can only be considered a variety of it, as I observed no larval differences. It differs in the more uniform and subdued tone of the front wings, the markings being more suffused and indistinct; but principally in the relative narrowness of the space outside the transverse posterior line the greater consequent width of the middle area, and smallness of the triangular brown spot—the space it occupies on the inner margin being scarcely one-half as wide as that between it and the transverse posterior line. The discal spots are also separated.

Described from one good specimen. An interesting fact connected with this variety is, that precisely the same form occurs in Europe, as I found a single specimen in the cabinet of M. J. Lichtenstein of Montpellier, France, which he had captured in that vicinity, and which he allowed me to bring home for comparison. It seems to be rare, even there, and whether indigenous or imported from this country, is a question yet to be solved.—[Fourth Rept., p. 41–42, Figs. 18, 19, 20.

ACROBASIS JUGLANDIS, LeBaron.—(Fig. 20, *d*)—I have bred this species from Hickory, but as Dr. LeBaron has also bred it abundantly from Walnut, and has signified his intention of describing it in his second annual Report, I adopt his proposed name, and shall content myself with pointing out the manner in which it may generally be distinguished from *nebulo*. Firstly, by the paler basal area of the front wings, which is sometimes almost white, especially near the costa, and by the head and shoulders and sometimes the ♂ antennal horn partaking of this paler color. Secondly, by the darker median space, the dark triangular costal spot not being well relieved posteriorly, but extending so as sometimes to darken the whole space. Thirdly, by the discal spots always being well separated.

Such are its specific characters as taken from 3 hickory-bred and 6 walnut-bred specimens; but of the former there is 1 which when placed alongside of some of the more abnormal specimens of *nebulo*, can scarcely be distinguished from them, and, if chosen without knowledge of its larva, would certainly be placed with them; while of the latter there are two which nearly as closely resemble the variety *nebulella*. In general characters, in the size of the brown triangular spot, and the manner in which the inner margin is divided, *juglandis* is intermediate between *nebulo* and *nebulella*. In one of the hickory-bred specimens, the general color is quite warm, and the basal area carneous rather than white.—[Fourth Rept., p. 43. Fig. 20, *a*, *b*, *d*.

Dr. LeBaron published his description of it about the same time, under the name *Phycita juglandis*, in his Second Report on the Insects of Illinois, p. 123.

PEMPELIA HAMMONDI, N. Sp. *Imago* (Fig. 21, *d*).—Average expanse 0.48 inch [=12^{mm}]. Front wings glossy purplish-brown with two silvery gray transverse bands dividing the wing on costa in about three equal parts, the basal band sharply defined outwardly and always extending to inner margin, the posterior band never extending more than half way across the wing, and generally not more than one-third, illy defined. In some specimens the basal transverse band is quite narrow, with the basal space a shade paler than the median: in others the band forms a double line. In some

specimens also, a narrow pale transverse line outside the second band, and a pale terminal shade, are visible. Hind wings uniformly paler gray. Under surface glossy gray, with no marks, the front wings a shade darker than the hind. ♂ differs from ♀ in the basal portion of the antennæ being curved, and the curve filled with a tuft of scales.

Described from numerous bred specimens. The species has the general facies of the European *Cryptoblabes bistriga*, which is a larger insect.

Larva.—Length 0.45—0.50 inch [=11—12.5^{mm}]. General color olive, or pale green, or brown, with a broad dark stripe along each side of back. Tapers slightly both ways, joints 4-12 inclusive, divided into two transverse folds. Freckled with numerous pale specks and with piliferous spots, the specks often taking the form of two pale broken lines along the upper edge of dark stripe. The piliferous spots are pale with a central black dot, and are best seen in the dark specimens. On joints 4-12 inclusive they are placed 4 in a square on the middle of the back, and four more each side, the two upper lateral ones being on the anterior fold, the stigmata appearing as minute rufous specks between them. Both these spots are often double. The third lateral spot is on the posterior fold and the fourth is subventral and anterior. The hairs proceeding from these spots are long and setaceous. Head horizontal, freckled, pale behind, tinged with green in front and with a few long hairs. Joint 1 also freckled and with a large black piliferous tubercle with a pale basal annulation and in range with middie of dark stripe. Joint 2 with similar black tubercles with a white centre and replacing the uppermost lateral pale spot. There are but two of the small pale dorsal piliferous spots on this joint (between the tubercles) as well as on joint 3. Beneath immaculate, except that the thoracic legs have sometimes a few dusky dots.

In the very dark specimens the head, cervical shield and anal plate remain pale. The cervical shield is then well defined with four small piliferous specks at anterior edge, and the large shiny tubercle forms the extreme anterior angle.

Described from numerous specimens.

Pupa.—0.24 inch [=6^{mm}] long; rather stout and short, with two minute diverging spines and a few stiff bristles at tip.

In many specimens the subdorsal dark stripe is obsolete or sub-obsolete, but even then the four black tubercles on joints 1 and 2 characterize the larva sufficiently.—[Fourth Rept., p. 46. Fig. 21.

TORTRIX RILEYANA, Grote—*Larva*—Length, Hickory feeding, 0.60-0.80 inch [=15—20^{mm}]; Snowberry feeding, 0.40-0.50 inch [=10—12.5^{mm}]. Largest on segment 2, tapering thence gradually to anus. Ground color dull yellow. Covered with large, distinct, black, sealing-wax-like, slightly elevated spots, each giving rise to several fine bristles. These spots are thus arranged on each segment: 2 each side of dorsum the posterior ones widest apart; 1 at sides in the middle of the segment, containing the stigmata in its lower hind margin; 1 smaller and narrower just below this, on a somewhat elevated longitudinal ridge, and 1 round one below this ridge on the posterior part of the segment. Segments 2 and 3 have but one spot each side of dorsum. Two distinct wrinkles on all the segments, more on 2 and 3. Head, cervical shield, and caudal plate black. Venter dirty yellow with black marks; legs ditto.

Chrysalis—Honey-yellow, robust in the middle, and with two transverse rows of minute teeth across the back of each segment.

Perfect Insect—From Hickory—Average expanse 1 inch, length of body, 0.35 [=8.8^{mm}]. Deep ochreous. Fore wings evenly washed with purplish, leaving the fringes and costal edge dark ochreous. The markings take the shape of dark velvety brown rounded maculations, generally of small size and faintly shaded with ochreous on the edges. Three of these subterminally at the base of the wing, subequal, situated interspaceally between the nervures. At a little within the middle of the costa are two fused maculations, the most prominent. Before and beyond these, some faint costal marks. At the extremity of the discal cell, above median nervure, is the first of a

series of maculations, normally four in number but not constant, usually uneven in size. A subterminal series of spots is inaugurated on costa by a large, compound shaded maculation. Below this, over the median nervules, sweeps an outwardly rounded series of small approximate dots. Two dots on costa, within and at the apex, and a faint terminal series of minute streaks is shortly discontinued. Hind wings of a lustrous bright deep ochreous; pale along the costal margin and darker shaded along internal margin. Beneath, as are the hind wings above; both wings immaculate, fore wings the darker. Body and appendages concolorous, bright deep ochreous. Antennæ simple. Numerous bred specimens.

From Snowberry—var. symphoricarpi—Much paler, the fore wings not being as dark as the hind wings of the above. The upper surface of fore wings not washed with purplish but merely of a darker ochreous than the hind wing. The maculations entirely similar but ferruginous, paler and the slighter costal marks obsolete. Legs at base and under thoracic surface almost whitish. Average expanse, 0.62 [=15.5mm]; length of body, 0.30 [=7.5mm]. Described from numerous specimens. Under surfaces exactly alike in both varieties.—[First Rept., p. 154. Fig. 85, and Pl. 2, Figs. 3, 4.

TORTRIX CINDERELLA, N. Sp.—*Imago.*—Alar expanse exactly 1-2 inch [=12.5mm]. Front wings deep glossy ash-gray, immaculate. Under a lens they have an irrorate appearance, while in certain lights some of the scales appear to form a series of darker transverse sinuous lines. Also scattered over the wing may be noticed a dozen or more reddish scales, which are not sufficient, however, to destroy the uniform immaculate appearance. Head, mouth-parts, antennæ, legs, and abdomen of same color. Hind wings paler and semi-transparent. Fringes of all wings concolorous. Under surface of wings pale nacreous, inclining to pale fulvous around the margins.

Described from two bred specimens.

Larva (Fig. 22, *a*).—Length 0.50 inch [=12.5mm]. Form of that of *Acrobasis nebulo*, wrinkled very much in the same manner. Color yellowish-green, the piliferous spots of the same color, but readily distinguished by their polished surface; they are placed in a transverse row on thoracic joints, and on joints 4—12 there are four trapezoidally on dorsum, two laterally on the first fold and one subventral. Stigmata between the two lateral spots, and yellowish. Head and cervical shield gamboge-yellow; only a shade darker than body; labrum and two basal joints of antennæ paler or white, the terminal joint brown; ocelli on a somewhat crescent-shaped black spot (the most conspicuous character) a second dusky spot at base of head laterally. Legs immaculate.

Described from many specimens.

Pupa (Fig. 22, *b*).—Length 0.25—0.30 inch [=6—7.5mm]. Brown, characterized by a peculiar rounded projection from front of head; by a little pointed prominence at base of each antennæ, and each side of penultimate abdominal joint; and by terminating in a broad suppressed piece which produces two decurved hooks. Posterior rim of abdominal joints rasped dorsally, and a slight rasped dorsal ridge near the anterior edge of larger joints. Legs reaching only to end of wing-sheaths. The head-prominence varies in size and slightly in form.—[Fourth Rept., p. 47.

From specimens reared from cranberry-feeding larvæ received from Mr. Jno. H. Brakeley, of Bordentown, N. J., I am satisfied that this is the same species briefly characterized by Packard in the 1st edition of his *Guide* (p. 334) as *Tortrix oxycoccana*, and that *T. malivorana* LeBaron (my Rep. IV, p. 47) is but a dimorphic orange form, subsequently described by Packard as *T. vacciniivorana* (Hayden's Report of the U. S. Geol. and Geogr. Survey of the Territories 1878, p. 522). The orange and ash-gray specimens are thus bred both from Apple and Cranberry. I have reared both forms from Cranberry and from Apple, and they are undistinguishable in the larva and pupa states. The gray form is often

more or less suffused with orange scales and the orange form less frequently with gray scales. This is the most remarkable case of dimorphism with which I am familiar in the family, and points strongly to the important bearing of biological facts on a true classification. The dimorphic coloring is not sexual, but occurs in both sexes. The eggs of this species are very flat, circular and translucent, with a diameter of 0.7^{mm}, and are laid singly on the underside of the leaf near the mid rib. The species belongs to the genus *Teras*, and as Packard's specific name *oxycoccana* has priority, the insect should be known as *Teras oxycoccana*, Pack. The insect, according to Mr. Brakeley, who gives an account of it in the Report of the Seventh Annual Convention of the New Jersey Cranberry Association (1879, p. 7), commonly affects, also, the high-bush whortleberry. The gray form of the moth is most frequent in autumn.

GELECHIA GALLÆSOLIDAGINIS, N. Sp.—*Larva.*—Length 0.60 [inch, = 15^{mm}]. Cylindrical. Color dark dull-brown, without shine. Largest on middle segments; tapering from 4th to head, and from 9th to extremity. Each segment impressed transversely in the middle, thus forming two folds, the thoracic segment having other such folds. Six small piliferous spots, two each side of dorsum and one above stigmata, which, together with the stigmata, are shiny and of a lighter brown than the body. Head and cervical shield light shiny-brown.

Chrysalis.—Length 0.50 [inch, = 12.5^{mm}]. Mahogany-brown. Form normal. Blunt at extremity.

Perfect moth.—Average length 0.38 [= 9.5^{mm}]. Alar expanse ♀ 0.95 [inch, = 24^{mm}], ♂ 0.75 [inch, = 18.8^{mm}]. Fore wings deep purplish-brown, more or less sprinkled with carneous. A light carneous band starts from the costa near the base, and curves towards the middle of the inner margin, which it occupies to a little beyond the beginning of the cilia, where it curves upwards towards the tip, reaching only half way up the wing. Here it is approached from above by a somewhat diffuse spot of the same color, which starts from the costa just behind the apex, and runs down to the middle of the wing.

In the plainly marked individuals there is an extra line running from the middle of the inner margin, outwardly obliquing to the middle of the wing, and then back to the inner margin a little beyond where the cilia commences, but in the great majority of specimens this mark is indistinct. Cilia light carneous. Hind wings slate-gray, with the cilia lighter. Antennæ finely annulated with the same two dark and light colors. Head, thorax and palpi light, with a sprinkling of the dark brown. Body dark, with light annulations. The species varies in the distinctness of its markings, and the light parts of the front wing appear finely sprinkled with brown under the lens. Male generally smaller than female, with the antennæ proportionately a little longer.

Described from numerous bred specimens.

It seems to resemble *G. longifasciella* of Clemens, in coloration and pattern; but unfortunately our late lamented microlepidopterist, failed almost always to give the measurement of the species he described, and it is impossible to tell how much mine resembles that species. Yet, as *longifasciella* was described from two mutilated specimens, received from A. S. Packard, jr., and as that gentleman has seen my insect and declared it an undescribed species, there can be little doubt of the fact.—[First Rept., p. 175. Pl. II, Figs. 1, 2, 5.

PTEROPHORUS CARDUI, N. Sp.—*Larva.*—Average length 0.60. Largest in the middle of body, tapering thence each way. Color light straw-yellow—greener when young. Somewhat darker, partly translucent, dorsal, subdorsal and stigmatal lines. Two lateral rows of black spots, the lower spots rather smaller and placed behind the

upper ones. A third row above these, and others along the back, but so small that they are generally imperceptible with the naked eye, except on the thoracic segments, being especially distinct on segment 2. Head small, black, sometimes inclining to brown. Cervical shield black, divided longitudinally in the middle by a lighter line. Caudal plate also black. Segment 11, besides the spots above mentioned, has two transverse black marks, the posterior one the largest. Thoracic legs black, the others of the same color as the body.

Described from 12 specimens.

Pupa.—Average length 0.45. Of form of Plate 2, Fig. 14. Soft, dull yellow, with a lateral dusky line each side of dorsum, and another, less distinct, each side of venter. Also dusky about the head and wing-sheaths.

Perfect insect.—Length 0.45; alar expanse 0.80. Front wings bifid, the cleft reaching not much more than ¼ of wing; tawny yellow, with a distinct dark brown triangular spot running from costa to the base of cleft—sometimes a little below it—its posterior margin with a slight concave curve. Three dusky, diffuse longitudinal spots, one placed on the basal third of the wing at costa and frequently reaching along the costa to the triangular spot; one near the interior margin, a little nearer to the base of wing than the last, and one on the outer third of the interior margin. Two light-colored transverse lines across the end of wing, one very near and parallel with posterior margin, the other bordering the triangular spot behind, and curving across the lower lobe towards posterior angle. The space between these two light lines usually darker than the ground-color. Fringes dark with a light margin. Hind wings trifid, the upper cleft reaching a little beyond the middle, the lower one to the base of wing. Color ashy-brown, the lower lobe produced into a dark angular spot about their middle posteriorly. Antennæ, palpi, head, thorax, and body, tawny yellow; legs of the same color with the exception of the tarsi, which are almost white, with alternate dark brown spots, the spines being black, with dusky tips.—[First Rept., pp. 180–181. Fig. 98, and Pl. II, Figs. 13, 14.

Zeller has since (1872) referred it to the genus *Platyptilia* (Beitr. zur Kenntn. N. A. Nachtfalter, 2nd part, p. 118), and indicates the difference between it and a very closely allied European species, *P. Zetterstedtii.* He very properly, because of the incongruous compound, drops the conventional ending *dactylus* which I used in the original description.

HETEROPTERA.

NYSIUS DESTRUCTOR, N. Sp.—General color grayish-brown; of shape of *N. thymi* Wolff. *Head* either minutely or more coarsely punctate, and more or less distinctly pubescent; the surface usually brown, with a distinct black, longitudinal line each side, broadening on the crown, but generally leaving the orbit of the eyes pale; these lines sometimes more diffuse and occupying the whole surface, except a median brown spot at base of crown, and a narrow, paler spot on the clypeus; ocelli piceous; eyes opaque, either black or slate-color; face sometimes uniformly pubescent and appearing dark grayish-brown; but more generally black each side of rostrum, with a distinct yellowish-brown spot on the cheeks below the eyes; rostrum piceous, paler at base and reaching to hind coxæ; antennæ either pale yellowish-brown or darker brown, the torulus and first joint darkest. *Thorax*, pronotum narrowing anteriorly, the sides slightly sinuate, irregularly and more coarsely punctate than the head, more or less pubescent, dingy yellow or brown, with a transverse black band near the anterior edge, obscuring the incision and leaving the edge pale, especially in the middle, where there is often a conspicuous pale spot; also five more or less distinct longitudinal dark lines, the central one most persistent and leading on the posterior margin to a pale, shiny, impunctate spot; the callus at hind angles, and sometimes an intermediate spot between it and the median one, and the entire posterior margin, also pale and impunctate; scutellum dark, coarsely punctate, sometimes with a smooth median lon-

gitudinal ridge ending in a pale spot, and with the lateral margins pale; prosternum dark, more or less pubescent, the anterior and posterior margins, and a band outside of coxæ, more or less broadly pale; mesosternum and metasternum also dark, with the pale spots outside of coxæ. *Legs* pale yellow, inclining more or less to brown; coxæ dark at base, pale at tip; trochanters pale; front and middle femora spotted more or less confluently on the outside with brown; hind femora, ♂ dark brown, except at tips and base; ♀ spotted only; tibiæ ringed with brown at base; tarsi marked more or less with brown, especially at tip. *Hemelytra* either colorless, transparent and prismatic, or distinctly tinged with dingy yellow; shallowly punctate and very finely pubescent, the veins of corium and clavus dingy yellow, with brown streaks, the more constant of these streaks being two on posterior margin of corium, and one at the tip of clavus. *Abdomen*, ♂ tergum piceous, with the sutures and sides of some of the joints rarely paler; venter piceous, minutely and regularly covered with gray pubescence; ♀ sutures and spots on tergum more often pale; venter dingy yellow, except at base; ♀ paler than ♂, and generally larger. Average length 0.13 inch [= 3.¼mm].

Larva.—Dingy yellow, with more or less distinct longitudinal dark lines, especially on head.

Pupa.—Same color, with more distinct red and brown longitudinal lines, and two little tooth-like, pale yellow processes at inner base of hemelytra pads, indicating the wings; the abdomen paler than the rest of the body.

Described from numerous specimens. I have some, especially males, in which the black so predominates that the paler parts of the head and thorax are scarcely traceable, while in others again the pale parts predominate almost to the exclusion of the black. Indeed, so variable is the species that it is difficult to see wherein some of the specimens differ from the European *thymi*, or from *N. angustatus* Uhler, and it is barely possible that future comparison will show specific identity between some or all of the three. But as long as authors fail to give the variation a species is liable to, or the number of specimens a description is drawn up from, it will remain impossible to decide such questions satisfactorily, and I name *destructor* at the suggestion of our Hemipterist, Mr. P. R. Uhler, of Baltimore, who has examined specimens which I sent him.—[Fifth Rept., p. 113. Fig. 41.

MYTILASPIS POMICORTICIS, N. SP.—*Eggs*—from 30 to 100 under each scale; length scarcely 0.01 inch, irregularly ovoid, nearly thrice as long as wide, snow-white, except just prior to hatching, when they become yellowish. *Larva*—Length of body 0.01 inch, ovoid, thrice as long as wide, pale yellow, with a darker yellow spot near each end; a few short hairs seen around border; two fine anal setæ about half as long as body springing from two lobes between which two spinous hairs are always seen; antennæ quite variable, the joints irregular and not easily resolved, sometimes appearing only 6-jointed, but more generally 7-jointed, with a few hairs, two or three at tip the longest and most persistent; legs with a one-jointed tarsus, a feeble claw, and, among other hairs, four more or less distinctly knobbed ones near tip, the two uppermost longest.

♂—Length of body, 0.022 inch [= .5.5mm]; color, translucent carneous-gray; a dorsal transverse band on each abdominal joint, and portions of the mesothorax and metathorax darker, or purple-gray; the members somewhat lighter. *Head*, sub-triangular; rostrum rudimentary; ocular tubercles, one each side of it, plainly visible, the eyes on the upper surface prominent, dark, and with few facets; antennæ as long as body, 10-jointed, joints 1 and 2 bulbous and sometimes indistinctly separated; 3—9 about four times as long as wide, slightly constricted; 10 half as long and fusiform; all but basal two with a whorl of about eight hairs, slightly clavate and as long as width of joint. *Thorax* very large, oval; prothoracic portion narrowing in front, composed of two transverse folds, the anterior one having a transverse row of four dusky dots; the mesothoracic portion large and elevated, showing three lateral swellings; a well-defined medio-dorsal plate, rounded in front, shallowly-notched behind, with a medio-

longitudinal suture, and a transverse one dividing it in two, the anterior half pale, the posterior darker; the metathoracic portion showing a sub-triangular scutel, and separated from mesothorax by the transverse band (*apodema* of Targioni). *Wings* about as long as body, arising from base of mesothorax, spatulate, closing flat on back in repose, and appearing whitish, finely and uniformly covered with short, stiff hairs; supported by a bifurcate vein, the bifurcation arising from basal fourth, and each fork running near and almost parallel with the wing-margins; balancers dark, with the hook quite long. *Legs* with the middle pair longest, and—from large size of coxæ —further from front than from hind pair; the coxæ and femora large and swollen, the latter with a more or less distinct lobe near the base below; the tarsi one-jointed, with a constriction occasionally indicated, and terminating in a single flexible claw, surrounded by four clubbed hairs; the tibiæ and tarsi are quite bristly, but on the femora there are usually but two bristles, one about the middle above, and one on the basal lobe below; the coxæ also have one above. *Abdomen*, seen from above, nearly as long as thorax; appearing shorter from below; 8 joints only discerned; the last joint abruptly narrowed into a large tubercle bearing four bristles on the under side, and sending forth the genital armor in the form of an awl-shaped style as long as the abdomen.

♂ Scale—Larval part golden yellow; the anal shield yellowish-brown, sometimes quite pale, inclining to white, flattened, straight, rather more than twice the length of larval scale, increasing in width from tip to end, where it is slightly truncate; attached by a white film; average length, 0.035 inch.

♀—Average length, 0.05 inch; color, pale yellow; jug-shaped and flattened when young, more globular when mature, and twice as long as wide; the cephalo-thoracic portion rounded and entire, but narrower than the abdominal, at the juncture with which it forms a more or less conspicuous lateral projection; on its inferior side is a tubercle, having two longitudinal ridges, and giving rise to a corneous, filiform proboscis, longer than the body, and composed of four separate parts; posterior abdominal joints deeply lobed laterally, with two or three blunt, fleshy hairs to each lobe; anal plate gamboge-yellow, corneous, with an irregular border, presenting two larger, slightly tri-lobed, median projections, and one or more smaller ones each side, furnished with spinous hairs, two especially between the tri-lobed projections aforenamed; five more or less complete sets of secretors visible from below, arranged around anus in form of an arc, the median set with normally 10, the upper laterals 20, and the lower laterals 14; besides these, some six or more blunt tubes, and a series of shorter pointed ones, may be noticed along the border, and doubtless serve as secretors. (See Fig. 32 *b*.)

♀ Scale—Larval scale golden-yellow; median scale somewhat darker; anal shield varying from pale brown to deep purplish-gray, and generally of a color with the bark it is upon. The whole scale is often incanous, but the hoary film easily rubs off; it averages 0.12 inch in length, but is quite variable in form and size, being either straight or curved, narrow and strongly arched, or broad and flatter, but always rounded at the end; the white inferior laminæ at sides sometimes show distinctly from above, and give the appearance of a pale border.

The lice, whether ♂ or ♀, vary in appearance according to position and state of maturity. In making the foregoing descriptions and figures, I have taken what appeared the most natural positions, after examination of many specimens. The ♂ abdomen shrinks very much in drying, and the more detailed ♀ characters are variable. While the normal number of secretors in the middle set is never more than 10, I have sometimes found but 8 or 9; that of the upper laterals never surpasses 20, but may be as low as 15; while that of the lower laterals is more uniformly 14, though I have sometimes found 16, and at others 12. Opposite sets do not always contain the same number.—[Fifth Rept., pp. 95–96. Figs. 31, 32.

This is the species previously known as *Aspidiotus conchiformis*, or popularly as the Oyster-shell Bark-louse, and the reasons for separating it are given in the report.

ERIOSOMA ULMI, N. Sp.—Color dark blue. Length to tip of closed wings, exclusive of antennæ, 0.12 [inch, =3mm]. Wings hyaline, three times as long as wide, and more pointed at the ends than in *E. pyri*. Costal and subcostal veins, and that bounding the stigma behind, robust and black. Discoidal veins together with the 3d forked and stigmal veins, all slender and black, the forked vein being as distinct to its base as are the others, with the fork but ¼ as long as the vein itself and curved in an opposite direction to the stigmal vein. Antennæ 6-jointed and of the same color as the body; joints 1, 2, 4, 5 and 6 of about equal length, joint 3 thrice as long as either. Legs of the same color as body.

The young lice are narrower and usually lighter colored than the mature individuals, varying from flesh or pink to various shades of blue and purple.—[First Rept., p. 124.

Professor Thomas (Trans. Ill. St. Hort. Soc., 1876, p. 191) has called it *Erisoma Rileyi** because of *ulmi* being preoccupied by an European species. It belongs to *Schizoneura*. For subsequent remarks see "Notes on the Aphididæ of the United States, etc., by C. V. Riley & J. Monell," (Bull. Hayden's U. S. Geol. & Geogr. Survey, Vol. V, No. 1, p. 3.)

DIPTERA.

ASILUS MISSOURIENSIS N. SP.—Alar expanse 1.85 [inches, = 47mm]; length of body 1.30 inches [=33mm]. *Wings* transparent, with a smoky yellow tinge, more distinct around the veins, which are brown. *Head* pale yellow, sometimes brownish; moustache straw-yellow with a few stiff black hairs below; beard pale straw-yellow; crown very deeply excavated; base of the same pale yellow with short, stiff, yellowish hairs, and a crown of black ones near the border; eyes large, prominent, finely reticulated and almost black; antennæ, first joint black tipped with brown, cylindrical and hairy; second joint black, short, thick and rounded at tip, with a few stiff hairs; third joint as long as first, tapering each way, smooth, black and terminating in a long, brown bristle; proboscis black and nearly as long as face; neck with pale and black hairs. *Thorax* leaden-black, slightly opalescent with reddish brown at sides, more or less pubescent with pale yellow, especially laterally and posteriorly and in three narrow longitudinal dorsal lines which gradually approach towards metathorax; bearded at sides and behind with a few decurved black bristles, those behind interspersed with a few smaller pale hairs; scutel of the same color, with upward-curving, black bristles; halteres brown. *Abdomen*, ♂, general color dull leaden-yellow, with darker transverse bands at insections; the light color produced by a yellowish pubescence and numerous short close-lying yellow hairs, the dark bands produced by the absence of this covering at the borders of each segment; basal segment broad, bilobed, and with lateral black bristles; segments 6, 7, 8 and anal valves with a decided pink tint, especially 7; 8 but one-third as long as 7 above. ♀, broader, flatter, more polished and brassy, with no transverse darker bands, segments 7 and 8 polished black, the latter narrow and longer than any of the others; anus with a few black bristles. *Legs*, dull purple-brown, with black bristles; thighs very stout, the hind pair rather darker than the others, the two front pair of trochanters with long, yellowish hairs; pulvilli, generally fulvous.

Described from two ♂, and two ♀, all captured while sucking honey-bees. I have not access to Loew's descriptions, and cannot therefore compare it with already described species; but specimens have been sent to Dr. Wm. LeBaron, of Geneva, Illinois, and to Baron Osten Sacken, of New York, and both these gentlemen are unacquainted with it, and believe it to be new. In the well marked ♂ specimens, the body bears a general resemblance to that of *Trupanea* [*Promachus*] *vertebrata*, Say.—[Second Rept., pp. 122-123. Fig. 89.

---

* By typographical error *Rilepi*.

Baron Osten Sacken has since placed this as a synonym of *Proctacanthus Milbertii* Macq. in the second edition of his Catalogue of the described Diptera of North America (1878), p. 81.

LYDELLA DORYPHORÆ, New Species.—Length 0.25 [=6mm]. Alar expense 0.48 [=12mm]. Antennæ black. Palpi fulvous. Face silvery white. Front silvery, tinted with pale golden-brown, with a broad middle stripe black. Thorax cinereous with imperfect black stripes. Abdomen black and silvery-ash, changing into each other when viewed from different angles. When viewed from above: first segment deep black with a posterior border of silver-ash very narrow in the middle, much widened laterally, but abbreviated at the sides of the abdomen. The other segments with the basal half silvery-ash, terminal half black. Legs black. Fourth longitudinal vein of the wings straight after the angle. Posterior transverse vein arcuate.

Described from numerous bred specimens.—[First Rept., pp. 111–112. Fig. 48.

This species is referred by Osten Sacken to the genus *Exorista* of Schiner, *Lydella* not being received as a distinct genus. The name *Lydella* is used also for a genus of Acarina.

EXORISTA FLAVICAUDA, N. Sp.—Length 0.35 to 0.50 inch [=8.5–12.5mm]. *Head* broader than thorax; face, silvery-white, the cheeks inclining to yellow, with lateral black hairs extending to near the base of antennæ, and one stiffer and longer bristle at top of cheeks; front, dusky, ferruginous, with two rows of black converging bristles; divided by a broad depressed stripe of a brighter ferruginous color and without bristles; occiput bright ferruginous; labium ferruginous with hairs of same color; maxi-palps rufous; eyes dark mahogany-brown, and *perfectly smooth;* antennæ, two basal joints rufous, with black hairs, third joint flattened, dusky, and thrice as long as second; seta, black; entire hinder part of head covered with dense white hairs. *Thorax,* more decidedly blue than in *leucaniæ, broader* (instead of narrower) in front than behind; the vittæ less distinct; scutel of same color as thorax. *Abdomen,* stout and more cylindrical than in *leucaniæ;* first joint dark bluish-gray; second, light bluish-gray, becoming darker along the middle, at sides and at lower border; third joint, like second above, but golden-gray at sides (no rufous); last joint *entirely* yellow or pale orange, with no other color and but few black bristles around anus. *Wings* more dusky than in *leucaniæ;* alulæ, opaque bluish-white. *Legs,* black; pulvilli pale yellow.

Described from one captured, 4 bred ♀. Space between eyes at occiput fully one-third the width of head.—[Second Rept., pp. 51–52. Fig. 18.

TACHINA [EXORISTA] PHYCITÆ, LeBaron—*Imago.*—Length, 0.20 inch [=5mm]. Antennæ black, third joint twice as long as the second; face silvery, without bristles at the sides; sides of the front silvery at the lower part, pale golden above; the middle black vitta occupying a little more than half of the width of the inter-ocular space; frontal bristles continued down the face to opposite the end of the second joint of antennæ; palpi blackish-brown; eyes hairy. Thorax black, with the ordinary cinereous stripes scarcely perceptible. Abdomen black, varied with cinereous at the base of the segments; a large fulvous spot on the side of the abdomen occupying nearly the whole of the side of the second segment, half or more of the third, and sometimes a small spot on the first; bristles on the middle as well as at the hind-margin of the second and third segments. Venation of the wings of the usual type; first posterior cell almost closed, before the end of wing; fourth long vein slightly curved after the angle; fifth long vein prolonged to the margin; hind cross vein moderately sinuous. Tarsal claws and pulvilli unusually long.

Female? A single specimen, a very little larger than the others, was obtained from the same lot of leaf-crumplers, which possibly may be the ♀ of the same species. It differs as follows: Front broader; antennæ dark brown; the cinereous markings of the body more distinct; the tip of abdomen fulvous, but without the fulvous spot at the sides; and with the tarsal claws of ordinary length.

This species appears to belong to the subgenus *Exorista* of Meigen, closely allied to *Tachina* proper, and differing from it chiefly in having the eyes hairy, and in the presence of bristles on the middle, as well as at the hind margin of the second and third abdominal segments, whereas *Tachina* has only the latter.—[Fourth Rept., p. 40–41.

This species was simultaneously published by Dr. LeBaron in his 2d Rept. Ins. Ill., p. 123. It is retained in *Exorista* by Osten Sacken.

ANTHOMYIA ZEAE ♀, N. Sp. (Pl. 2, Fig. 24). Length 0.20 [inch, $=5^{mm}$]; alar expanse 0.38 [inch, $=9.5^{mm}$]. Antennæ black; style microscopically pubescent; front, fulvous, with a distinct, rather narrow, brownish, cinereous margin; face and orbits brownish-white; palpi and proboscis black; ocellar area somewhat heart-shaped; thorax and abdomen pale yellow-brownish cinereous, with minute black points at the insertion of the bristles; thorax with an indistinct middle stripe of brown; legs black, tinted with cinereous; poisers pale ochre-yellow; scales small, the upper valve larger than the lower.—[First Rept., p. 155. Figs. 86, 87, and Pl. II, Fig. 24.

ANTHOMYIA RADICUM (Linn.) var. CALOPTENI—*Egg*—Oval, smooth, white, 0.04 inch long.

Larva—Skin unarmed, 0.24 inch [$=6^{mm}$] long when extended, of the normal form, the mandibular hooks black, quite conspicuous, and diverging at base. Prothoracic spiracles elongate. Anal spiracles minute, yellowish-brown, with the 8 fleshy surrounding tubercles, small.

Pupa—Pale-brown, rounded at each end, with the prothoracic spiracles and lips anteriorly, and the anal spiracles and lower tubercles posteriorly, showing as minute points.

Imago—♀. Average expanse 0.48 inch [$=12^{mm}$]. General color ash-gray with a ferruginous hue, especially above, and a more or less intense metallic reflection. Face with white reflections below; eyes smooth, brown, encircled by the ground color, and this behind and on forehead bordered by a brown line; 2 similar lines at back of head from upper corners of eyes and approaching to neck; forehead dusky-brown, becoming bright yellowish-red toward base of antennæ, and the brown forking at right angles around occiput. Trophi and antennæ black, the style simple and somewhat longer than the whole antennæ. Thorax with three dusky longitudinal lines, obsolete behind; legs black, with cinereous hue beneath; wings faintly smoky, with brown-black veins, the discal cross-vein straight and transverse, the outer one bent and more oblique; balancers crumpled, yellowish. Abdomen with faint dusty medio-dorsal spots, broad at base, tapering and obsolescing toward end of each joint.

In the ♂, aside from the larger eyes, stronger bristles, and narrower, less tapering abdomen with its additional joint—all characteristic of the sex—the face is whiter, and the medio-dorsal dark mark of abdomen continuous.

Described from 25 specimens of both sexes, reared from locust-egg-feeding larvæ.

Specimens bred from cabbage and radish roots, and others in my cabinet taken from the burrows (made in Osage Orange in Missouri) of *Crabro stirpicola* Pack.; do not differ specifically.—[Ninth Rept., p. 95.

For further details see First Rept. of the Commission (pp. 285–9), where the species is shown to be the *Anthomyia angustifrons* of Meigen.

ORTHOPTERA.

CALOPTENUS ATLANIS N. sp.—Length to tip of abdomen 0.70—0.85 inch [$=17.5$—21^{mm}]; to tip of closed wings 0.92—1.05 inches [$=23$—26^{mm}]. At once distinguished from *femur-rubrum* by the notched character of the anal abdominal joint in the male and by the shorter, less tapering cerci; also by the greater relative length of wings which extend, on an average, nearly one-third their length beyond the tip of the abdomen in the dried specimens: also by the larger and more distinct spot on the wings—in all which characters it much more closely resembles *spretus* than *femur-rubrum*.

From *spretus*, again, it is at once distinguished by the smaller size, the more distinct separation of the dark mark running from the eyes on the prothorax and of the pale line from base of wings to hind thigh; also by the anal joint in the ♂, tapering more suddenly and by the two lobes forming the notch being less marked. From both species it is distinguished not only by its smaller size but by the deeper, more livid color of the dark parts, and the paler yellow of the light parts—the colors thus more strongly contrasting.

6 ♂'s, ♀ 7's from New Hampshire. Just as the typical *femur-rubrum* is at once distinguished from the typical *spretus* by the characters indicated; so *Atlanis*, though structurally nearer to *spretus*, is distinguished from it at a glance by its much smaller size and darker, more marbled coloring. The contrast is all the greater in the living specimens, and I have seen no specimens of *spretus* that at all approach it in these respects.

Whether this is the *femur-rubrum* as defined by DeGeer or by Harris, it is almost impossible to decide, though Harris's figure of *femur-rubrum* better represents it than the true *femur-rubrum*, as subsequently defined by Thomas, and as found in Illinois and Missouri.—[Seventh Rept., pp. 169–170.

For further details and structural differences between it and *C. spretus* see First Report of the Commission.

LIST OF DESCRIPTIONS OF ADOLESCENT STATES.

In making out the following list of descriptions of adolescent states, etc., that appeared in the Reports, the nomenclature there used is retained. Unless otherwise stated the insects, in the particular states indicated, were at the time unknown or undescribed, the descriptions first appearing in the Reports. Those published in connection with the preceding descriptions of new species are omitted here:

HYMENOPTERA.

Nematus ventricosus; *larva:* IX, 21. (Previously described by several writers.)

Pristiphora grossulariæ; *larva:* IX, 26. (Description quoted from Walsh.)

Emphytus maculatus; *larva* and *pupa:* IX, 28–29. (Previously described by me in the *Prairie Farmer*, May 25, 1867.)

Lophyrus abbotii; *larva:* IX, 32.

Lophyrus lecontei; *larva:* IX, 33. (This and *abbotii* both partially described by me in the *Prairie Farmer*, November 10, 1866; May 25, 1867; May 2, 1868, and in the *Prairie Farmer Annual*, 1869.)

Tiphia inornata; *larva:* VI, 126.

COLEOPTERA.

Harpalus (probably herbivagus Say); *larva:* IX, 97.

Harpalid; *larva:* I, 59.

Mysia 15-punctata; *larva:* IV, 18.

Chilocorus bivulnerus; *larva* and *pupa:* I, 16.

Hippodamia convergens; *larva* and *pupa:* I, 112. (Previously mentioned in the *Am. Ent.* I, 46, and elsewhere.)

Coccinella picta; *larva:* V, 101.

Passalus cornutus; *larva* and *pupa:* IV, 140–141. (Previously mentioned by Burmeister and by Walsh.); *egg:* V, 55.

LACHNOSTERNA QUERCINA; *egg:* V, 55.

Pelidnota punctata; *larva* and *pupa:* III, 78–79. (First described by me in *Am. Ent.* II, 295.)

Telephorus bilineatus; *larva:* IV, 30. (First described by Packard.)

Chauliognathus pensylvanicus; *larva:* I, 57. (Quoted from the *Am. Ent.* I, 35.)

Chrysobothris femorata; *eggs:* VII, 73: *larva,* I, 46. (Previously described by Fitch and others); *eggs, larva,* and *pupa:* VII, 73.

Sinoxylon basilare; *larva* and *pupa:* IV, 54.

Corynetes rufipes; *larva* and *pupa:* VI, 101, 102.

Prionus laticollis; *larva:* I, 126; *larva* and *pupa:* II, 87; *egg:* V, 56.
laticollis.)

Saperda bivittata; *pupa:* I, 43. (Previously described by Harris.)

Lema trilineata; *larva* and *pupa:* I, 99. (From the *Prairie Farmer*; and the *Am. Ent.* I, 26. Previously described by Harris and others.)

Doryphora juncta; *larva:* I, 106. (First described in the *Am. Ent.* I, 43.)

Doryphora 10-lineata; *eggs* and *larva:* I, 105. (From the *Am. Ent.* I, 43. Previously described by me in *Prairie Farmer* Aug. 8, 1863.

LEPIDOPTERA.

Eudryas unio; *larva* and *pupa:* VI, 92. (First described by Lintner.)

Alypia octomaculata; *larva:* I, 136, (previously mentioned by Fitch); II, 80, published simultaneously in the *Am. Ent.*, II, 151, (previously described in *Harris' Corr.*); VI, 94.

Procris americana; *larva* and *pupa:* II, 86. (First described by Harris.)

Callimorpha fulvicosta; *larva:* III, 134.

Spilosoma virginica; *larva* and *pupa:* III, 69. (Previously described by various authors.)

Hyphantria textor; *larva:* III, 132. (First described by Harris.)

Ecpantheria scribonia; *larva:* IV, 143. (Previously described by other authors.)

Bombyx mori; *egg* and *larva:* IV, 86. (Previously well known.)

Attacus cecropia; *larval changes:* IV, 106. (Quoted from the *Am. Ent.* II, 100.)

Attacus cynthia; *larval changes:* IV, 117. (Previously described by other authors.)

Attacus promethea; *larval changes:* IV, 121. (Partially given by other authors previously.)

Attacus luna; *larval changes:* IV, 124. (Previously given by Lintner.)

Attacus polyphemus; *larval changes:* IV, 126.

Attacus yama-maï; *larval changes:* IV, 132. (Previously described by other authors.)

Attacus pernyi; *egg, larva,* and *cocoon:* IV, 137. (Previously described by other authors)

Hemileuca maia; *egg* and *larval changes:* V, 128, 129. (Previously described by Lintner.)

Hyperchiria io; *larval changes:* V, 135. (Previously given by Lintner.)

Anisota rubicunda; *eggs* and *larval changes:* V, 138.

Acronycta oblinita; *larva* and *pupa:* III, 71. (The larva first figured by Smith & Abb.)

Acronycta xylinoides; *larva:* V, 126.

Amphipyra pyramidoides; *larva* and *pupa:* III, 73, 74.

Leucania unipuncta; *larva* and *pupa:* II, 49; VIII, 33, and *larva:* II, 55 (previously described by various authors); *egg:* VIII, 34; *egg* and *larval changes:* VIII, 184, 185.

Gortyna nitela; *larva:* I, 92. (From the *Am. Ent.*, II, 22. Briefly described by Harris, *Treatise*, p. 440; but first identified by me in the *Prairie Farmer.*)

Agrotis inermis; *larva* and *pupa:* I, 74.

Agrotis cochranii; *larva* and *pupa:* I, 76. (First described by me in the *Prairie Farmer*, June 22, 1867.)

Agrotis clandestina; *larva* and *pupa:* I, 79. (Previously mentioned by Harris.)

Agrotis telifera; *larva* and *pupa:* I, 81. (Described by me in the *Prairie Farmer*, June 22, 1867; and previously described in Europe, where the species also occurs and is known as *A. ypsilon.*)

Agrotis subgothica; *larva:* I, 82.

Agrotis jaculifera; *larva* and *pupa:* I, 83.

Agrotis devastator; *larva* and *pupa:* I, 84.

Hadena subjuncta; *larva* and *pupa:* I, 85.

Celæna renigera; *larva* and *pupa:* I, 86.

Prodenia commelinæ; *larva:* I, 88; III, 114 (from *Am. Ent.*, II, 363). [See Notes.]

Anisopteryx vernata; *larva* and *pupa:* II, 95–97 (previously described by other authors); *eggs, larva* and *pupa:* VII, 82 (and 86–87, adapted from Mann); Paleacrita vernata, VIII, 13–17 (from the Trans. St. Louis Acad.)

Anisopteryx pometaria; *eggs:* II, 94–95 (the two species confounded); *eggs, larva* and *pupa:* VII, 84 (and 86–87, adapted from Mann); VIII, 13–17 (from the Trans. St. Louis. Acad.)

Eufitchia ribearia; *egg, larva* and *pupa:* IX, 3, 4. (The larva first described by Fitch.)

Phacellura nitidalis; *larva:* II, 67.

Asopia costalis; *larva* and *pupa:* VI, 106. (The *larva* mentioned by Harris, but first described by Walsh in the *Prac. Ent.*, and first bred and determined by me, *Prairie Farmer*, April 20, 1867.)

Phycita nebulo; *larva* and *pupa:* IV, 41. (The larva first described by LeBaron.)

Pempelia grossulariæ; *larva* and *pupa:* I, 141. (Larva previously described by Fitch and by Packard.)

Tortrix rileyana; *larva* and *pupa:* I, 154.

Anchylopera fragariæ; *larva:* I, 143. (First described in the *Am. Ent.*, I, 90.)

Penthina vitivorana: *larva* and *pupa:* I, 135. (The larva first described, but not identified, by Rathvon.)

Carpocapsa pomonella; *larva* and *pupa:* I, 63. (Previously described by various authors.)

Walshia amorphella; *larva* and *pupa:* II, 133.

Bucculatrix pomifoliella; *larva* and *pupa:* IV, 51. (Larva previously described by Clemens.)

Œta compta; *larva* and *pupa:* I, 152.

Pterophorus periscelidactylus; *larva* and *pupa:* I, 137; III, 66. (Previously described by Fitch.)

Pterophorus carduidactylus; *larva* and *pupa:* I, 180.

Pronuba yuccasella; *larva:* V, 155; *pupa*, VI, 131 (from Trans. St. Louis Acad.); *egg*, VI, 133 (from *Am. Nat.*).

Orgyia leucostigma; *eggs*, *larva* and *pupa:* I, 144–146. (Previously described by others.)

Thyridopteryx ephemeræformis; *eggs*, *larva* and *pupa:* I, 148, 149. (Previously described by others.)

Hæmatopis grataria; *eggs*, *larva* and *pupa:* I, 179.

Galleria cereana; *larva* and *pupa:* I, 166. (Previously described by other authors.)

HEMIPTERA.

Strachia histrionica; *eggs*, *larva* and *pupa:* IV, 37.

Micropus leucopterus; *egg*, *larval stages* and *pupa:* VII, 21.

Cicada septemdecim; *egg* and *young larva:* I, 25. (The eggs previously described by several writers.)

Pœciloptera pruinosa; *eggs:* V, 122.

Ceresa bubalus; *eggs:* V, 121.

Mytilaspis pinifoliæ; *eggs* and *larva:* V, 98. (First mentioned by LeBaron.)

Phylloxera rileyi; *larva* and *pupa:* VI, 64, 86; VII, 120.

Phylloxera vastatrix; *various forms:* VI, 66 (previously described elsewhere and by others); *impregnated egg:* VIII, 159. (Previously described by me in the Trans. St. Louis Acad. for Oct. 18, 1875, and independently by Balbiani in the Comptes rendus de l' Ac. d. Sc. Paris for Oct. 4, 1875.)

Eriosoma pyri; *larva:* I, 120. (From the *Am. Ent.*, I, 82; previously described by several authors.)

DIPTERA.

Tabanus atratus; *larva* and *pupa:* II, 130, 131. (Previously described, but not specifically identified, by Walsh.)

Erax bastardi; *larva* and *pupa:* II, 124.

Bombyliid; *larva:* IX, 96.

Pipiza radicum; *larva* and *pupa:* I, 122. (Quoted from the *Am. Ent.*, I, 84.)

Anthomyia zeæ; *larva* and *puparium:* I, 155.

Meromyza americana; *larva* and *pupa:* I, 160.

Œstrus ovis; *larva* and *puparium:* I, 162. (Previously described by other authors.)

ORTHOPTERA.

Mantis carolina; *eggs* and *larva:* I, 170–171. (Previously described by several authors.)

Œcanthus niveus; *eggs:* V, 120. (Previously described as eggs of Ceresa bubulus by Fitch.)

Orchelimum glaberimum; *eggs:* V, 123.
Phaneroptera curvicauda; *eggs:* V, 124, and VI, 165; *larva* and *pupa:* VI, 166.
Microcentrus retinervis; *eggs:* V, 123; VI, 155 (previously described as eggs of Platyphyllum by Harris); *larva* and *pupa:* VI, 161.
Phylloptera oblongifolia; *eggs:* V, 123. (See Microcentrus.)
Platyphyllum concavum; *eggs:* V, 124; VI, 167.
Caloptenus spretus; *eggs* and *egg-mass:* IX, 88, 89; *larva* and *pupa:* VII, 129.

NEUROPTERA.

Corydalus cornutus; *larva* and *pupa:* V, 143, 144 (Previously described by Haldeman); *eggs* and *egg-mass,* and *young larva:* IX, 127.

LIST OF DESCRIPTIONS, MOSTLY AMPLIFIED, OF SPECIES NOT NEW.

The following list includes the species, already known, of which a complete redescription of the adult is given in the Reports, either because the original description was in a foreign language, or not easily accessible, or of one sex only, or for other reasons.

HYMENOPTERA.

Tiphia inornata *Say:* VI, 126.
Cryptus extrematis *Cress.:* IV, 111.
Pezomachus minimus *Walsh:* II, 52. (From Walsh.)
Ophion purgatus *Say:* II, 53.
Mesochorus vitreus *Walsh:* II, 52. (From Walsh.)
Pimpla annulipes *Brullé:* V, 49.
Macrocentrus delicatus *Cress.:* V, 50.
Microgaster militaris *Walsh:* II, 52. (From Walsh.)
Chalcis mariæ *Riley:* IV, 110. (From the *Am. Ent.*, II, 101–102.)
Isosoma vitis *Saunders:* II, 93. (From Saunders.)
Antigaster mirabilis *Walsh:* VI, 163. (From the *Am. Ent.*, II, 169–170.)
Pristiphora grossulariæ *Walsh:* IX, 26–27. (From the *Prac. Ent.*, I, 123.)
Nematus ventricosus (*Klug*): IX, 22. (From the *Prac. Ent.*, I, 120–121, and the *Am. Ent.*, II, 16–17.)
Emphytus maculatus *Nort.:* IX, 28.
Lophyrus LeContei *Fitch:* IX, 33.

COLEOPTERA.

Doryphora 10-lineata *Say*, var.: IX, 40.
Sphenophorus zeæ *Walsh:* III, 59. (From Walsh.)
Scolytus caryæ *Riley:* V, 107. (Female first described in *Prairie Farmer* Feb. 2, 1867.) [See Notes.]

LEPIDOPTERA.

Apatura lycaon (*Fabr.*): VI, 144.
Apatura herse (*Fabr.*): VI, 144.
Megathymus yuccæ (*Walk.*): VIII, 175–176.
Ægeria polistiformis *Harr.:* III, 76.
Ægeria acerni *Clem.:* VI, 110.
Prodenia autumnalis *Riley:* III, 116–117. (From *Am. Ent.*, II, 365.) [See Notes.]
Leucania unipuncta *Haw.:* II, 56.
Leucania albilinea *Guen.:* IX, 56–57.
Acronycta oblinita *Sm. & Abb.:* III, 71.
Amphipyra pyramidoides *Guen.:* III, 74.
Celæna renigera *Steph.:* I, 86.
Hadena subjuncta *Gr. & Rob.:* I, 85.
Noctua clandestina *Harr.:* I, 79.

Agrotis inermis *Harr.*: I, 74.
Agrotis cochranii *Riley*: I, 75.
Agrotis telifera *Harr.*: I, 81.
Agrotis jaculifera *Guen.*: I, 83.
Anisopteryx pometaria *Harr.*: VIII, 15–17. (From the Trans. St. Louis Acad. Sc.)
Paleacrita vernata (Peck): VIII, 15–17. (From the Trans. St. Louis Acad. Sc.)
Asopia costalis (*Fab.*): VI, 107.
Pempelia grossulariæ (*Pack.*): I, 141.
Walshia amorphella *Clem.*: II, 133.
Penthina vitivorana *Pack.*: I, 135.
Euryptychia sa igneana *Clem.*: II, 134. (From Clemens.)
Tortrix rileyana *Grote*: I, 154.
Walshia amorphella *Clem.*: II, 133.
Holcocera glandulella *Riley*: IV, 145. (From the *Can. Ent.*, IV, 18–19.)
Pronuba yuccasella *Riley*: V, 150, 151, 155; VI, 131–132. (Both from the Trans. St. Louis Acad. Sc.)
Œta compta *Clem.*: I, 153.

HEMIPTERA.

Micropus leucopterus (*Say*): VII, 21, 22.
Mytilaspis pinifoliæ (*Fitch*): V, 99.
Eriosoma pyri (*Fitch*): I, 120.
Phylloxera vastatrix *Planchon*: VIII, 159 (From Trans. St. Louis Acad. Sc.); VI, 66–67; VII, 93, 99.
Phylloxera Rileyi *Licht.*: IV, 66; VI, 64, 86; VII, 118–120.
Phylloxera caryæ-gummosa *Riley*: VII, 118. (From the *Comptes Rendus*, Paris Acad. of Sci., Dec. 14, 1874.)
Phylloxera caryæ-ren *Riley*: VII, 118. (From the *Comptes Rendus*, Paris Acad. of Sci., Dec. 14, 1874.)
Phylloxera caryæ-fallax *Riley*: VII, 118. (From the *Comptes Rendus*, Paris Acad. of Sci., Dec. 14, 1874.)

DIPTERA.

Erax bastardi *Macq*: II, 124.
Pipiza radicum *Walsh & Riley*: I, 121–122. (From the *Am. Ent.* I, 83–84.)
Exorista leucaniæ *Walsh*: II, 51. (From Walsh.)
Tachina bifasciata (*Fabr.*): V, 140.

ORTHOPTERA.

Caloptenus femur-rubrum (*DeG.*): VII, 126–128.
Caloptenus atlanis *Riley*: VIII, 117.
Caloptenus spretus (*Thos.*): VII, 128–132; VIII, 117.

ACARINA.

Hoplophora arctata *Riley*: VI, 81. (From Trans. St. Louis Acad., III, 216.)
Tyroglyphus phylloxeræ *Riley & Planchon*: VI, 81. (From Trans. St. Louis Acad., III, 215.)

LIST OF ILLUSTRATIONS.

The illustrations in the Reports were prepared at the author's expense, neither the State nor the Board of Agriculture making any provision therefor. The wood-engraving was done for the most part in St. Louis, by either Wm. Macwitz, Emile Lampe, or Wittemberg & Sorber. Some of it was done by Van Ingen & Snyder, of Philadelphia. A few of the later illustrations are by photo-engraving, and Figs. 50–52 of the 8th Report show the first attempt to combine this process with lithography. In the following list, all drawings were made from nature by the author unless otherwise stated, and when the figure is enlarged the natural size, unless otherwise apparent or stated in this list, will be found indicated in hair-line. The nomenclature of the Reports is retained.

REPORT I.

WOOD-CUTS.

REPORT II.

REPORT III.

REPORT IV.

FIG. 28. Grape Phylloxera (*Phylloxera vitifoliæ*, Fitch = *Ph. vastatrix* Pl.); *a*, shows a healthy root; *b*, one on which the lice are working, representing the knots and swellings caused by their punctures; *c*, a root that has been deserted by them, and where the rootlets have commenced to decay; *d*, *d*, *d*, shows how the lice are found on the larger roots; *e*, female pupa, dorsal view; *f*, same, ventral view; *g*, winged female, dorsal view; *h*, same, ventral view; *i*, magnified antenna of winged insect; *j*, side view of the wingless female, laying eggs on roots; *k*, shows how the punctures of the lice cause the larger roots to rot.

FIG. 29. Mulberry Silkworm (*Bombyx mori* Linn.), larva.

FIG. 30. Mulberry Silkworm (*Bombyx mori* Linn.), cocoon.

FIG. 31. Mulberry Silkworm (*Bombyx mori* Linn.), moth.

FIG. 32. Mulberry Silkworm (*Bombyx mori* Linn.), cocoons; *a*, White French Annual; *b*, Yellow French Annual; *c*, Green Japanese Annual; *d*, White Japanese Annual; *e*, White Chinese Annual.

FIG. 33. Cecropia Silkworm Moth (*Attacus Cecropia* Linn.).

FIG. 34. Cecropia Silkworm (*Attacus Cecropia* Linn.), cocoon.

FIG. 35. Cecropia Silkworm (*Attacus Cecropia* Linn.), chrysalis.

FIG. 36. Cecropia Silkworm (*Attacus Cecropia* Linn.).

FIG. 37. *Ophion macrurum*, Linn. [After Packard.]

FIG. 38. *Ophion macrurum*, Linn., larva.

FIG. 39. Mary Chalcis-fly (*Chalcis mariæ* Riley).

FIG. 40. Cecropia Cryptus (*Cryptus samiæ* Pack.), cocoons within the larger Cecropia cocoon.

FIG. 41. Cecropia Cryptus (*Cryptus samiæ* Pack.); *a*, female; *b*, female abdomen of *C. nuncius*; *c*, male abdomen; *d*, highly magnified piece of wing.

FIG. 42. Ailanthus Silkworm (*Attacus cynthia*, Hübn.); 1, caterpillar; 2, moth; 3, cocoon; 4, chrysalis; 5, eggs.

FIG. 43. Promethia Silkworm (*Attacus promethea* Drury); *a*, third stage; *b*, head in fourth stage, enlarged; *c*, lateral view of a joint in fourth stage, enlarged; *d*, full-grown caterpillar.

FIG. 44. Promethia Silkworm (*Attacus promethea* Drury), cocoon.

FIG. 45. Promethia Moth (*Attacus promethea* Drury), male. [After Harris.]

FIG. 46. Promethia Moth (*Attacus promethea* Drury), female. [After Harris.]

FIG. 47. Luna Moth (*Attacus Luna* Linn.). [After Harris.]

FIG. 48. Luna Silkworm (*Attacus Luna* Linn.).

FIG. 49. Luna Silkworm (*Attacus Luna* Linn.), cocoon. [After Harris.]

FIG. 50. Polyphemus Moth (*Attacus Polyphemus* Linn.), male.

FIG. 51. Polyphemus Moth (*Attacus Polyphemus* Linn.), female. [After Harris.]

FIG. 52. Polyphemus Silkworm (*Attacus Polyphemus* Linn.). [After Trouvelot.]

FIG. 53. Polyphemus Silkworm (*Attacus Polyphemus* Linn.), cocoon. [After Trouvelot.]

FIG. 54. Polyphemus Silkworm (*Attacus Polyphemus* Linn.), chrysalis. [After Trouvelot.]

FIG. 55. Yama-maï Moth (*Attacus yama-maï*, Guér.-Mén.), male.

FIG. 56. Yama-maï Silkworm (*Attacus yama-maï*, Guér.-Mén.); egg, natural size and enlarged; young caterpillar on leaf; full grown caterpillar at rest on twig.

FIG. 57. Yama-maï Silkworm (*Attacus yama-maï*, Guér.-Mén.), at rest on leafy twig, at *a*. [After Adams.]

FIG. 58. Yama-maï Silkworm (*Attacus yama-maï*, Guér.-Mén.), cocoon.

FIG. 59. Cage for receiving the deposition of the eggs of Yama-maï Moth. [After Adams.]

FIG. 60. Pernyi Moth (*Attacus Pernyi*, Guér.-Mén.).

FIG. 61. Pernyi Silkworm (*Attacus Pernyi*, Guér.-Mén.); egg, natural size and enlarged cocoon.

REPORT V.

FIG. 29. Apple-tree Tent-caterpillar (*Clisiocampa americana* Harr.), eggs.

FIG. 30. Grape Phylloxera (*Phylloxera vastatrix* Plan.); *a*, *b*, peculiar pedunculated galls; *c*, gall just forming; *d*, same from beneath.

FIG. 31. Oyster-shell Bark-louse (*Mytilaspis pomicorticis* Riley); *a*, male louse from beneath; *b*, same from above and with wings expanded; *c*, male scale; *d*, leg of male; *e*, portion of wing very highly magnified; *f*, one joint of male antennæ (all highly magnified).

FIG. 32. Oyster-shell Bark-louse (*Mytilaspis pomicorticis* Riley); anal joint of louse, with a more highly magnified segment of edge at *b*, and of a single pore at *c*; *d*, female louse; *e*, a section of its proboscis more highly magnified; *g h f*, female scale, *h*, first scale, *g*, second scale, *f*, third scale.

FIG. 33. Mite (*Dermalcichus?*).

FIG. 34. *Aphelinus mytilaspidis* LeBaron.

FIG. 35. Pine-leaf Scale-insect (*Mytilaspis pinifoliæ*, Fitch.); *a*, scales on leaves of white pine; *b*, male scale; *c*, female scale from white pine; *d*, female scale from broader leaved pine (*b*, *c* and *d*, enlarged).

FIG. 36. Pine-leaf Scale-insect (*Mytilaspis pinifoliæ*, Fitch); male, highly magnified.

FIG. 37. Painted Ladybird (*Coccinella picta* Randall); *a*, larva; *b*, beetle; *c*, beetle, enlarged.

FIG. 38. Hickory Bark-borer (*Scolytus caryæ* Riley); 1, view of its galleries on the inside of the bark, showing the beetle in the central gallery and the larvæ at the ends of the side galleries; 2, burrows made by larger larvæ; 3, beetle, magnified and natural size; 4, larva, magnified and natural size; 5, pupa, magnified; 6, sculpture of elytra, magnified.

FIG. 39. Rose Chafer (*Macrodactylus subspinosus*, Fabr.), with the enlarged anterior tibia at the left.

FIG. 40. Chinch-bug (*Micropus leucopterus*, Say).

FIG. 41. False Chinch-bug (*Nysius destructor* Riley); *a*, potato leaf showing some effects of its punctures; *b*, pupa; *c*, mature bug.

FIG. 42. Grape-vine Apple-gall (*Vitis-pomum* Walsh & Riley); *a*, exterior; *b*, section.

FIG. 43. Gall-gnat (*Cecidomyia salicis-strobiloides* Walsh), *a*, female; *b*, male antennæ.

FIG. 44. Grape-vine Filbert-gall (*Vitis-coryloides* W. & R.); *a*, anterior joints of larva, showing breast-bone; *b*, cluster of galls; *c*, section of single gall.

FIG. 45. Grape-vine Tomato-gall (*Vitis-tomatos* Riley = *Lasioptera vitis* O. S., gall); *a*, section of a single swelling.

FIG. 46. Grape-vine Trumpet-gall (*Vitis-viticola* Riley = *Cecidomyia viticola* O. S.)

FIG. 47. Jumping Tree-cricket (*Orocharis saltator* Uhler) eggs in grape twig; *a*, eggs; *b*, punctures; *c*, egg, enlarged.

FIG. 48. Jumping Tree-cricket (*Orocharis saltator* Uhler); *a*, female; *b*, male.

FIG. 49. Snowy Tree-cricket (*Œcanthus niveus* Harr.) eggs; *a*, punctures in twig; *b*, section of twig showing the eggs within; *c*, egg, enlarged; *d*, granulations at rounded end of egg, more highly magnified.

FIG. 50. Buffalo Tree-hopper (*Ceresa bubalus* Fabr.) eggs in slits in the bark of a tree; *a*, one slit enlarged; *b*, natural size.

FIG. 51. Buffalo Tree-hopper (*Ceresa bubalus*, Fabr.); *a*, side; *b*, dorsal view.

FIG. 52. Buffalo Tree-hopper (*Ceresa bubalus*, Fabr.); *a*, larva; *b*, pupa; *c*, ovipositor of the female, all enlarged.

FIG. 53. Egg-punctures of Tree-hopper (?) on apple twigs; *a*, natural size; *b*, enlarged.

FIG. 54. Frosted Lightning-hopper (*Pœciloptera pruinosa*, Say) eggs; *a*, enlarged; *b*, in position within twig, enlarged; *c*, natural size.

FIG. 55. Frosted Lightning-hopper (*Pœciloptera pruinosa*, Say).

FIG. 56. Egg-punctures of (?) *Orchelimum glaberimum* (Burm.).

FIG. 57. Eggs of the Angular-winged Katydid (*Microcentrus retinervis*, Burm.); *a*, front; *b*, side view, just before hatching.

REPORT VI.

FIG. 6. Grape Phylloxera (*Phylloxera vastatrix* Plan.)—Type Radicicola; *a*, shows a healthy root; *b*, one on which the lice are working, representing the knots and punctures caused by their punctures; *c*, a root that has been deserted by them, and where the rootlets have commenced to decay; *d*, *d*, *d*, show how the lice are found on the larger roots; *e*, female pupa, dorsal view; *h*, same, ventral view; *i*, magnified antenna of winged insect; *j*, side view of the wingless female, laying eggs on roots; *k*, shows how the punctures of the lice cause the larger roots to rot.

FIG. 7. Grape Phylloxera (*Phylloxera vastatrix* Plan.). Pterogostic characters; *a*, *b*, different venation of front wing; *c*, hind wing; *d*, *e*, *f*, showing development of wings.

FIG. 8. Grape Phylloxera (*Phylloxera vastatrix* Plan.)—Type Radicicola; *a*, *b*, pupa and imago of a problematical individual or supposed male; *c*, *d*, its antenna and leg; *e*, vesicles found in abdomen.

FIG. 9. Thrips, enlarged, wings at right more highly enlarged.

FIG. 10. Lace-wing fly (*Chrysopa* sp.); *a*, eggs; *b*, larva; *c*, cocoon, the upper figure with the lid open after the fly has escaped; *d*, fly, the wings omitted on the left. [*a*, *b*, *d*, after Westwood.]

FIG. 11. Ladybird (*Hippodamia convergens* Gué.); larva, pupa and beetle.

FIG. 12. Syrphus larva; *b*, one joint enlarged.

FIG. 13. Syrphus-fly (*Helophilus latifrons* Loew).

FIG. 14. Insidious Flower-bug (*Anthocoris insidiosus*, Say).

FIG. 15. Root-louse Syrphus-fly (*Pipiza radicum* W. & R.); *a*, larva; *b*, pupa; *c*, fly.

FIG. 16. Phylloxera Mite (*Tyroglyphus phylloxeræ* Planchon & Riley); *a*, dorsal; *b*, ventral view of female; *c*, mouth parts; *d*, *f*, *g*, *h*, forms of tarsal appendages; *e*, ventral tubercles of male.

FIG. 17. *Hoplophora arctata* Riley; *a*, *b*, *c*, *d*, *e*, different attitudes assumed by it; *f*, strongly magnified leg.

FIG. 18. American Oak Phylloxera (*Phylloxera Rileyi* Lichtn.); *a*, pupa; *b*, winged females; *c*, antenna greatly enlarged; *d*, portion of infested leaf, under side.

FIG. 19. American Oak Phylloxera (*Phylloxera Rileyi* Lichtn.); *a*, *b*, dorsal and ventral views of larva as seen hibernating; *c*, *d*, highly magnified leg and antenna of same.

FIG. 20. Grape-vine Epimenis (*Psychomorpha epemenis*, Drury); *a*, larva; *b*, one joint, enlarged, side view; *c*, hump on joint 11.

FIG. 21. Grape-vine Epimenis (*Psychomorpha epimenis*, Drury), male moth.

FIG. 22. Beautiful Wood-nymph (*Eudryas grata*, Fabr.); *a*, full grown larva; *b*, one joint, enlarged, side view; *c*, cervical shield from behind; *d*, anal hump from behind; *e*, *f*, top and side views of egg.

FIG. 23. Beautiful Wood-nymph (*Eudryas grata*, Fabr.), female moth.

FIG. 24. Pearl Wood-nymph (*Eudryas unio*, Hübn.), male moth.

FIG. 25. Eight-spotted Forester (*Alypia octomaculata*, Fabr.); *a*, larva; *b*, one joint, enlarged, side view; *c*, female moth.

FIG. 26. Red-legged Ham-beetle (*Corynetes rufipes*, Fabr.); *a*, larva; *b*, pupa; *c*, cocoon; *d*, beetle, enlarged; *e*, same, natural size; *f*, leg of larva; *g*, mandible, *h*, labium, *i*, maxilla, *j*, antenna, of larva—all enlarged.

FIG. 27. Larder-beetle (*Dermestes lardarius* Linn.); *a*, larva; *b*, one of its barbed hairs; *c*, beetle.

FIG. 28. Clover-hay Worm (*Asopia costalis*, Fabr.); 1, 2, larva; 3, cocoon; 4, chrysalis; 5, 6, moth with wings expanded, and closed; 7, worm covered with silken web.

FIG. 29. Legged Maple Borer (*Ægeria acerni*, Clem.); *a*, *a*, larva, dorsal and lateral views; *b*, *b*, *b*, cocoons exposed by detachment of bark; *c*, moth; *d*, chrysalis skin as it is often left remaining in the hole of exit.

FIG. 51. Narrow-winged Katydid (*Phaneroptera curvicauda* DeGeer); *a*, ovipositor of female, nat. size; *d*, end of same, enlarged; *c*, anal appendage of male, side view; *b*, same, back view.
FIG. 52. Broad-winged Katydid (*Platyphyllum concavum* Harr.); male (after Harris). [Adapted from Harris.]
FIG. 53. Broad-winged Katydid (*Platyphyllum concavum* Harr.); *a*, ovipositor of female, nat. size; *b*, end of same, enlarged.
FIG. 54. Eggs of Broad-winged Katydid (*Platyphyllum concavum* Harr.); *a*, side; *b*, front view—enlarged; *c*, *d*—natural size.
FIG. 55. Oblong-winged Katydid (*Phylloptera oblongifolia*, DeGeer), outline of female [adapted from Harris]; *b*, end of ovipositor, enlarged.

REPORT VII.

FIG. 1. Gray's Improved Sprinkler, for the use of Paris Green water. [From inventor.]
FIG. 2. Chinch-bug (*Micropus leucopterus*, Say).
FIG. 3. Chinch-bug (*Micropus leucopterus*, Say); *a*, *b*, eggs; *c*, newly hatched larva; *d*, its tarsus; *e*, larva after first molt; *f*, same after second molt; *g*, pupa, the natural sizes indicated at sides; *h*, enlarged leg of perfect bug; *j*, tarsus of same still more enlarged; *i*, proboscis or beak, enlarged.
FIG. 4. Chinch-bug (*Micropus leucopterus*, Say), short-winged form.
FIG. 5. Spotted Ladybird (*Hippodamia maculata*, DeGeer). [From *Practical Entomologist.*]
FIG. 6. Trim Ladybird (*Coccinella munda* Say).
FIG. 7. Insidious Flower-bug (*Anthocoris insidiosus*, Say).
FIG. 8. Many-banded Robber (*Harpactor cinctus*, Fabr.); *a*, bug; *b*, its beak, enlarged.
FIG. 9. False Chinch-bug (Nysius destructor Riley); *b*, pupa; *c*, mature bug.
FIG. 10. Ash-gray Leaf-bug (*Piesma cinerea* Say).
FIG. 11. Flea-like Negro-bug (*Corimelæna pulicaria*, Germar); natural size and enlarged.
FIG. 12. Flat-headed Apple-tree Borer (*Chrysobothris femorata*, Fabr.); *a*, larva, dorsal view; *b*, pupa; *c*, swollen thoracic joints of larva from beneath; *d*, beetle.
FIG. 13. Cherished Bracon (*Bracon charus* Riley).
FIG. 14. Spring Canker-worm (*Anisopteryx vernata*, Peck); *a*, full grown larva; *b*, egg, enlarged, the natural size shown in the small mass at the side; *c*, *d*, one joint enlarged, side and dorsal views.
FIG. 15. Spring Canker-worm (*Anisopteryx vernata*, Peck); *a*, male moth; *b*, female do.—natural size; *c*, joints of her antennæ; *d*, joint of her abdomen, showing spines; *e*, her ovipositor—enlarged.
FIG. 16. Spring Canker-worm (*Anisopteryx vernata*, Peck); front view of head.
FIG. 17. Fall Canker-worm (*Anisopteryx pometaria* Harr.); *a*, *b*, egg, side and top views; *c*, *d*, side and top views of one joint of larva,—enlarged; *e*, batch of eggs; *f*, full grown larva; *g*, female chrysalis—natural size; *h*, top view of anal tubercle of chrysalis.
FIG. 18. Fall Canker-worm (*Anisopteryx pometaria* Harr); *a*, male moth; *b*, female do.—natural size; *c*, joints of her antennæ; *d*, joint of her abdomen—enlarged.
FIG. 19. Phylloxera, Male (*Phylloxera caryæcaulis*, Fitch ?).
FIG. 20. Grafting; *a*, *b*, incisions to receive the scion; *d*, scion; *c*, string to secure scion—to prevent phylloxera injury.
FIG. 21. Grafting—to prevent phylloxera injury.
FIG. 22. American Oak Phylloxera (*Phylloxera rileyi* Licht.); *a*, male, ventral view; *b*, genital organ; *c*, tarsus—all greatly enlarged.

REPORT VIII.

REPORT IX.

FIG. 13. *Uropoda americana* Riley; *a*, Colorado Potato-beetle attacked by it—nat. size; *b*, the mite, ventral view, showing the penetrating organ lying between the legs; *c*, the organs extended; *d*, the claw; *e*, the excrematitious filament—all greatly enlarged.

FIG. 14. Wheat-head Army-worm (*Leucania albilinea* Guen.); *a*, *a*, larvæ; *b*, eggs—nat. size; *c*, *d*, egg, top and side view—enlarged.

FIG. 15. Wheat-head Army-worm moth (*Leucania albilinea* Guen.).

FIG. 16. *Map* of North America, illustrating the country east of the Rocky Mountains overrun by the Rocky Mountain Locust in 1876.

FIG. 17. *Acridium americanum*, Drury.

FIG. 18. Rocky Mountain Locust (*Caloptenus spretus* Thomas); *a*, *a*, *a*, female in different positions, ovipositing; *b*, egg-pod extracted from ground, with the end; *c*, a few eggs lying loose on the ground; *d*, *e*, shows the earth partially removed, to illustrate an egg-mass already in place and one being placed; *f*, shows where such a mass has been covered up.

FIG. 19. Rocky Mountain Locust (*Caloptenus spretus* Thomas); Anal characters of female, showing horny valves of ovipositor; *b*, an upper valve; *c*, lower valve—all enlarged.

FIG. 20. Rocky Mountain Locust (*Caloptenus spretus* Thomas); oviposition—*i*, superanal plate; *h*, sponge-like exsertile organ—the egg passing through the horny valves of the ovipositor, *g*.

FIG. 21. Rocky Mountain Locust (*Caloptenus spretus* Thomas), egg-mass, enlarged; *a*, side view within burrow, the line of exit of the young locusts shown at *d* and *e*; *b*, egg-mass from beneath; *c*, same from above.

FIG. 22. Rocky Mountain Locust (*Caloptenus spretus* Thomas); *a*, egg, enlarged to show sculpture of outer shell; *b*, portion of same very highly magnified; *c*, the inner shell, just before hatching; *d*, *e*, points where it ruptures.

FIG. 23. Anthomyia Egg-parasite (*Anthomyia radicum*, Linn., var. *calopteni* Riley); fly; *b*, puparium; *c*, larva, side view; *d*, head of same, from above—enlarged.

FIG. 24. Bombyliid larva (*Systœchus* sp.); *a*, enlarged; *b*, head, side view, more enlarged; *c*, do., front view; *d*, posterior spiracle. [See Notes, etc., p. 60.]

FIG. 25. Harpalus? larva; *a*, from above; *b*, head, from beneath; *c*, leg—enlarged; *d*, antenna; *e*, maxilla; *f*, labium.

FIG. 26. Harpalus? larva; A, natural size; B, under side of head, enlarged; *c*, mandible; *e*, antenna; *f*, labium and labial palpi; *g*, maxilla and maxillary palpi; *h*, joint 12 beneath; *i*, joint 11 beneath; *j*, joints 4–10 each beneath—enlarged.

FIG. 27. Pennsylvania Ground-beetle (*Harpalus pensylvanicus*, DeGeer).

FIG. 28. *Erax bastardi* Macq.; *a*, larva; *b*, pupa.

FIG. 29. *Amblychila cylindriformis* Say.

FIG. 30. Hellgrammite (*Corydalus cornutus*, Linn.); *a*, larva; *b*, pupa; *c*, fly, male; *d*, head of female fly.

FIG. 31. Hellgrammite (*Corydalus cornutus*, Linn.); *a*, *a*, egg-masses attached; *b*, one detached, showing lower surface,—all rather below average size; *c*, a few eggs of the outer row; *d*, the newly-hatched larva; *e*, labium; *f*, antenna; *g*, maxilla; *h*, mandible; *i*, tarsal claw; *j*, anal hooks—all enlarged.

FIG. 32. Eggs of *Belostoma?*

FIG. 33. Gigantic Water-bug (*Belostoma grandis* Linn.).

CLASSIFIED LIST OF ILLUSTRATIONS.

The following list of illustrations, brought together in classificatory order, will prove serviceable to entomologists, as it will enable such to readily ascertain whether or not any particular insect of a particular Order has been figured in the Reports. The explanations to the figures are omitted, since they are already given in the preceding list. The nomenclature of the Reports is here, also, retained, and references to figures other than those of insects or their products are omitted. The number of the Report is indicated in Roman and of the figure in Arabic numerals.

LEPIDOPTERA.

HETEROPTERA.

HOMOPTERA.

DIPTERA.

ORTHOPTERA.

NEUROPTERA.

ARACHNIDA.

ACARINA.

GENERAL INDEX.

In this general index each report is referred to in Roman and the page in Arabic numerals. The index to the new matter of this Bulletin is also included and referred to by the abbreviation "Supp."

C.

E.

F.

G.

H.

M.

X.

Y.

Z.

INDEX TO PLANTS AND FOOD-PLANTS.

A.

D.

E.

H.

Q.

R.

T.

U.

V.

ERRATA.

Page III, line 9, for CLASSIFED read CLASSIFIED.

Page 60, line 17, for LEUCANEÆ read LEUCANIÆ.

Pages 93, 94. In making up these pages several of the names got misplaced. "Orgyia" and "Thyridopteryx," on p. 94 should follow "Ecpantheria" on p. 93. "Hæmatopis," on p. 94, should follow "Eufitchia," on p. 93. "Pronuba" and "Galleria," p. 94, should follow "Carpocapsa," on the same page; "Œstrus" should follow "Pipiza" on the same page.

Page 94. After line 10 add "Gelechia gallæsolidaginis, *larva* and *pupa*: I, 173–174."